VAISALA

USER'S GUIDE

Vaisala DEWCAP® Precision SAW Hygrometer DM500

M210205EN-D

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CHAPTER 1

GENERAL INFORMATION

This chapter provides general notes for the product.

About This Manual

This manual contains instructions for performing accurate dewpoint measurements with Precision SAW Hygrometer DM500.

Version Information

Table 1 Manual Revisions

Manual Code	Description
M210205EN-A	1st version, August 2001
M210205EN-B	2nd version, April 2002
M210205EN-C	3rd version, February 2004
M210205EN-D	4th version, May 2005

Feedback

Vaisala Customer Documentation Team welcomes your comments and suggestions on the quality and usefulness of this publication. If you find errors or have other suggestions for improvement, please indicate the chapter, section, and page number. You can send comments to us by e-mail: manuals@vaisala.com

Safety

General Safety Considerations

Throughout the manual, important safety considerations are highlighted as follows:

WARNING	Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death.

CAUTION	Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.

NOTE	Note highlights important information on using the product.

Product Related Safety Precautions

The DM500 Precision SAW Hygrometer delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

WARNING	Ground the product, and verify outdoor installation grounding periodically to minimize shock hazard.

CAUTION	Do not modify the unit. Improper modification can damage the product or lead to malfunction.

ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench. When this is not possible, ground yourself to the equipment chassis before touching the boards. Ground yourself with a wrist strap and a resistive connection cord. When neither of the above is possible, touch a conductive part of the equipment chassis with your other hand before touching the boards.
- Always hold the boards by the edges and avoid touching the component contacts.

Regulatory Compliances

Tämä laite on pienjännitedirektiivin 73/23/ETY mukainen !

- Lue käyttöopas kokonaan ja huolellisesti ennen kuin käytät laitetta.
- Ennen kuin liität laitteeseen virran, varmista, että virtalähteen syöttöjännite on sama kuin laitteeseen liitetyssä tuotetietokilvessä mainittu käyttöjännite.
- Kytke verkkojohto maadoitettuun pistorasiaan !
- DMP501- ja DMI500-laitteiden sisällä ei ole käyttäjän huollettavissa olevia osia. Vahingollisen jännitteen aiheuttamien vahinkojen välttämiseksi laitetta ei saa avata kuin Vaisalan valtuuttama huoltohenkilöstö.
- Älä käytä laitetta yhdessä syttyvien, voimakkaasti reagoivien tai myrkyllisten kaasujen kanssa. Varmista tuuletuksen riittävyys ennen laitteen käyttämistä muiden kaasujen kuin ilman kanssa.
- Älä kokoa laitetta ympäristössä, jossa järjestelmässä poistuva tiivistynyt vesi saattaa aiheuttaa vaaratilanteita (esimerkiksi korkeajännitteisten virtalähteiden päällä).
- Kun lämmitintoiminto on käytössä, älä kosketa anturikammion kuumaa suojusta. Käytä hansikkaita, kun irrotat suojuksen.

Den här produkten uppfyller lågspänningsdirektivet (73/23 EEC) !

- Läs igenom hela användarhandboken noga innan du använder produkten.
- Innan du ansluter produkten i vägguttaget, bör du kontrollera att nätspänningen överensstämmer med den driftsspänning, som anges på typskylten som finns på produkten.
- Det finns inga delar inuti DMP501- eller DMI500-mätaren, som ska underhållas av användaren. För att undvika att säkerhetsrisker uppstår med farlig spänning får höljet aldrig avlägsnas, utom av auktoriserad servicepersonal från Vaisala.

- Anslut inte brandfarliga, mycket reaktiva eller giftiga gaser till instrumentet. Se till att ventilationen är tillräcklig vid användning av andra gaser än luft.
- Sätt inte samman instrumentet i en lokal där kondensvatten som droppar ut ur systemet kan orsaka en farlig situation, till exempel ovanpå högspänningsutrustning.
- Rör inte vid det heta locket på mätprobens kammare med fingrarna när uppvärmningsfunktionen har aktiverats. Använd handskar när du ska ta av locket.

Dieses Produkt entspricht der Niederspannungsrichtlinie (73/23 EWG) !

- Lesen Sie die Bedienungsanleitung vor Verwendung des Geräts sorgfältig und vollständig durch.
- Vergewissern Sie sich vor dem Anschließen an eine Steckdose, dass die Netzspannung der Betriebsspannung entspricht, die auf dem Typenschild des Produkts angegeben ist.
- Die Systeme DMP501 und DMI500 enthalten keine vom Benutzer zu wartenden Teile. Zur Vermeidung von Sicherheitsrisiken durch gefährliche Spannungen darf das Gehäuse nur von befugtem Vaisala-Wartungspersonal geöffnet werden.
- Halten Sie das Gerät von entflammbaren, hoch reaktiven und giftigen Gasen fern. Sorgen Sie bei Verwendung anderer Gase als Luft für ausreichende Belüftung
- Montieren Sie das Gerät nicht an Orten, an denen aus dem System tropfendes Kondenswasser eine Gefahr darstellen kann, wie z. B. über Hochspannungversorgungen.
- Bei aktivierter Heizfunktion darf der heiße Deckel der Sensorkammer nicht mit bloßen Händen angefasst werden. Verwenden Sie zum Abnehmen des Deckels Handschuhe.

Ce produit est conforme à la Directive relative à la Basse Tension (73/23 EEC) !

- Bien lire le guide de l'utilisateur dans son intégralité avant utilisation.
- Avant de brancher dans une prise, vérifier que la tension électrique de fonctionnement correspond à la tension de fonctionnement mentionnée sur la plaque signalétique attachée au produit.
- Le DMP501 ou le DMI500 ne contiennent pas de pièces susceptibles d'être réparées par l'utilisateur. Afin d'éviter tout danger lié à la tension électrique, le boîtier ne peut être ouvert que par un employé de maintenance autorisé de Vaisala .
- Ne pas raccorder à l'instrument tous gaz inflammables, réactifs ou toxiques. Veiller à une ventilation correcte lors de l'utilisation de gaz différents de l'air.
- Ne pas assembler l'instrument dans un endroit où de l'eau condensée s'échappant du système pourrait provoquer un danger, par exemple, au-dessus d'une alimentation en haute tension.
- Lorsque la fonction de réchauffage est activée, ne pas toucher le couvercle chaud de la chambre du capteur à mains nues. Porter des gants pour détacher le couvercle.

Questo prodotto è conforme alla Direttiva sulla Bassa Tensione (73/23 EEC) !

- Si prega di leggere attentamente e completamente la guida per l'utente prima dell'uso.
- Prima del collegamento a una presa di corrente, controllate che il vostro voltaggio operativo corrisponda al voltaggio operativo specificato nella targhetta indicatrice del prodotto.
- Il DMP501 o il DMI500 non contengono al loro interno parti utilizzabili dall'utente. Per evitare rischi alla sicurezza con un voltaggio pericoloso, il coperchio non deve essere aperto se non dal personale autorizzato Vaisala.
- Non collegate gas infiammabili, altamente reattivi o tossici allo strumento. Assicurate una ventilazione adeguata quando gas diversi dall'aria vengono usati.

- Non posizionate lo strumento in un luogo dove l'acqua condensata che fuoriesce dal sistema potrebbe causare un pericolo, come su alimentatori elettrici ad alto voltaggio.
- Quando la funzione di riscaldamento è attiva, non toccate a mani nude il tappo caldo della camera di misurazione. Si prega di usare dei guanti per togliere il tappo.

Este producto cumple con la Directiva sobre baja tensión (73/23 CEE) !

- Lea todo el manual de usuario atentamente antes de utilizar el producto.
- Antes de enchufarlo a un conector, compruebe que el voltaje operativo corresponde al que se menciona en el tipo de placa que se adjunta al producto.
- En DMP501 y en DMI500 no existen partes que puedan resultar prácticas para el usuario. Para evitar que se produzcan accidentes debidos a tensiones peligrosas, únicamente el personal del servicio autorizado de Vaisala podrá abrir la carcasa.
- No conecte al instrumento gases tóxicos, muy reactivos o inflamables. Asegúrese de que la ventilación es la adecuada al utilizar gases que no sean aire.
- No monte el instrumento en una ubicación donde el vapor del agua condensada pueda provocar algún peligro como, por ejemplo, en la parte superior de una fuente de alimentación de alto voltaje.
- Cuando se activa la función del calentador, no toque la tapa caliente de la cámara del sensor con las manos sin protección. Utilice guantes cuando vaya a quitar la tapa.

Dette produkt over direktivet om svagstrøm (73/23 EEC) !

- Læs hele brugervejledningen omhyggeligt, før du tager enheden i brug.
- Før du tilslutter enheden til en stikkontakt, skal du kontrollere, at den lokale spænding svarer til den spænding, der er angivet på pladen med produktoplysninger.
- Der er ingen dele inde i DMP501 eller DMI500, som kan efterses af brugeren. Med henblik på at undgå risiko for skader, er delene med farlig spænding afdækket, og kabinettet på må kun fjernes af autoriserede Vaisala-serviceteknikere.
- Undgå, at brændbare, højreaktive og giftige luftarter kommer i nærheden af enheden. Sørg for tilstrækkelig udluftning, når der benyttes andre luftarter end almindelig luftluft.
- Undgå at montere enheden et sted, hvor kondenseret vand kan dryppe ud af systemet og forårsage skader, f.eks. over et stærkstrømsstik.
- Når varmefunktionen er aktiveret, skal du undgå at berøre topdækslet på sensorkammeret med bare hænder. Brug handsker, når du tager dækslet af.

Dit product voldoet aan de Laagspanningsrichtlijn (73/23 EEC) !

- Lees de volledige gebruikershandleiding aandachtig door voordat u het apparaat in gebruik neemt.
- Voordat u het apparaat op een stopcontact aansluit, controleert u of de plaatselijke bedrijfsspanning overeenkomt met de bedrijfsspanning die wordt vermeld op het typeplaatje dat op het product is bevestigd.
- Er bevinden zich geen onderdelen in de DMP501 of DMI500 die door de gebruiker kunnen worden onderhouden. Om veiligheidsrisico's als gevolg van gevaarlijke spanningsniveaus te voorkomen, mag de behuizing alleen worden geopend door bevoegd onderhoudspersoneel van Vaisala.
- Sluit geen brandbare, sterk reactieve of giftige gassen aan op het instrument. Zorg voor voldoende ventilatie wanneer u met andere gassen dan lucht werkt.
- Monteer het instrument niet op een locatie waar condenswater dat uit het systeem druppelt tot een gevaarlijke situatie kan leiden, zoals boven op voedingseenheden met hoge spanning.

- Raak het hete kapje van de sensorbehuizing niet met blote handen aan als de verwarmingsfunctie is geactiveerd. Maak het kapje alleen los met handschoenen aan.

Trademarks

License Agreement

Warranty

For certain products Vaisala normally gives a limited one-year warranty. Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

CHAPTER 2

PRODUCT OVERVIEW

This chapter introduces the features and advantages of Precision SAW Hygrometer DM500.

Product Description

DM500 is a high accuracy dewpoint temperature measuring instrument capable of measuring dewpoints down to -75 ºC with an accuracy of ± 0.2 ºC.

The DM500 system consists of the user interface unit DMI500 and the dewpoint sensing unit DMP501. Four of the following quantities can be displayed at a time:

- Dewpoint/frostpoint $\mathbf{T_{d/f}}$ (ºC or ºF), more about dewpoint/frostpoint on page 128.
- Dewpoint $\mathbf{T_d}$ (ºC or ºF)
- Partial water vapour pressure $\mathbf{P_w}$ (mbar)
- Humid air volume/dry air volume $\mathbf{H_2O}$ (ppmv)
- Relative humidity **RH** (%)
- Wet-bulb temperature **Tw** (ºC or ºF)
- Absolute humidity **a** (g/m3 or gr/ft3)
- Mixing ratio **x** (g/kg or gr/lb)
- Enthalpy **h** (kJ/kg or btu/lb)
- Difference of T and $T_{d/f}$ **T** (ºC or ºF)
- Temperature **T** (ºC or ºF)
- Pressure **P** (bar, hPa, psi, torr)

- Air flow rate **flow** (slpm, scfh)

The DM500 system includes two packages including the following parts:

DMI500

- DMI500 user interface unit
- Serial cable for EIA-232 (RS232)
- CD-Rom including MI70 Link software; to transfer logged data to your PC
- Power cable (according to the customer's requirement)

DMP501

- DMP501 dewpoint sensing unit
- Swagelok spare tube fittings for 1/4" tubes for the sample gas line (to replace default tube fittings (6 mm)
- Allen key; to remove the sensor cap and to adjust the sample flow.
- Water tubing for the condense water outlet

Front Panels

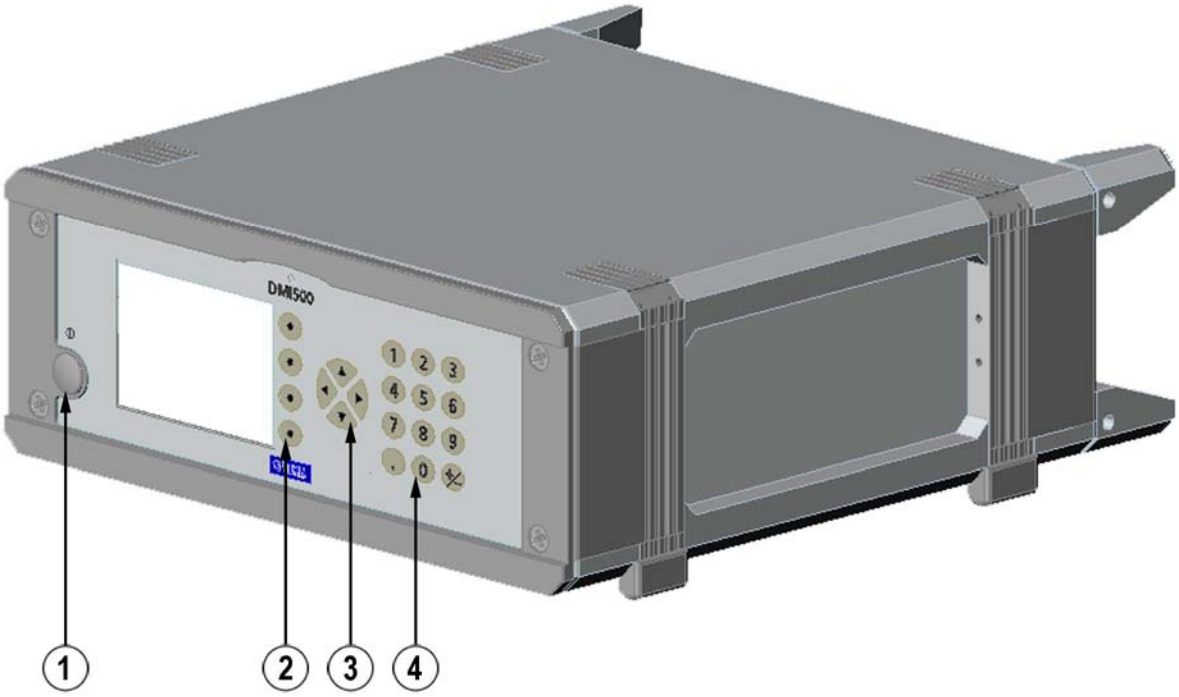

Figure 1 DMI500 User Interface Unit Front Panel

The following numbers refer to Figure 1 above:

1 = Mains switch ⏻. Press to turn the device on/off.
2 = Configurable softkeys ⊙. Press down to activate the menu function shown beside the button.
3 = Arrow keypad ►. Press any of the arrow buttons to open path for the menus. In the menus, you can navigate with arrow buttons. Up and down arrows for moving in the menu, right-pointing arrow for selecting menu item, left-pointing arrow for returning to previous menu.
4 = Numeric keypad. Numerical input can be given with the number keypad.

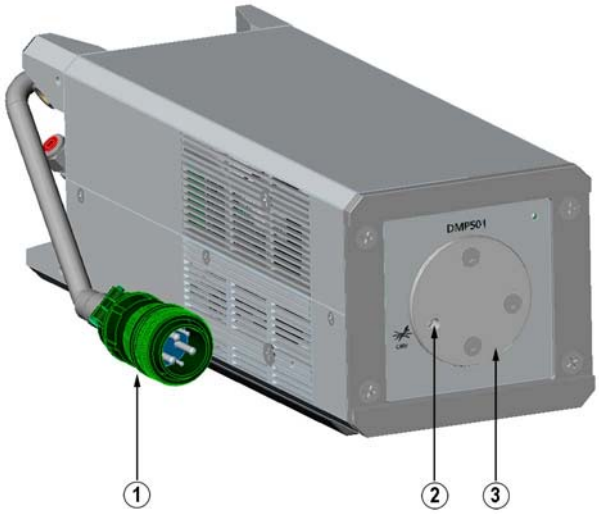

Figure 2 DMP501 Dewpoint Sensing Unit Front Panel

The following numbers refer to Figure 2 above:

1 = Power/data cable; connect to the back panel of the DMI500.
2 = Allen screw for adjusting the sample flow.
3 = Sensor cup; three Allen screws to open the cup for sensor cleaning.

NOTE	Warranty is void if DMP501 or DMI500 case is opened by the user!

Back Panels

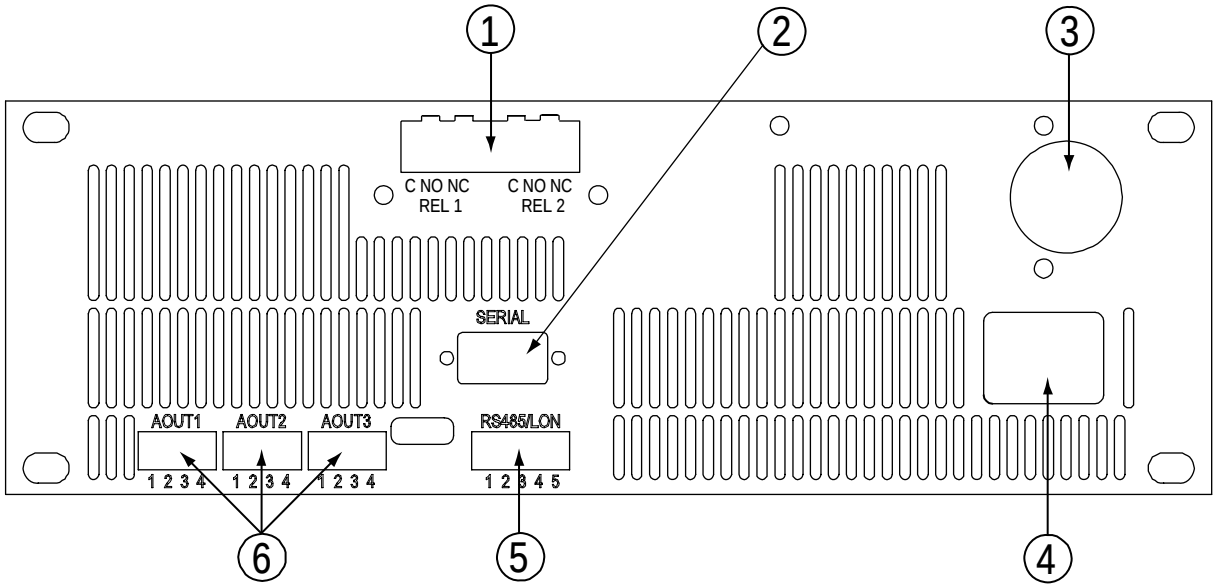

Figure 3 DMI500 User Interface Unit Back Panel

The following numbers refer to Figure 3 above:

1 = Relay outputs (optional)
2 = Serial port (EIA-232, RS232 for Terminal/MI70-link
3 = Connection to DMP501
4 = Mains cable
5 = RS485 and LonWorks-port (optional)
6 = Analog outputs (optional)

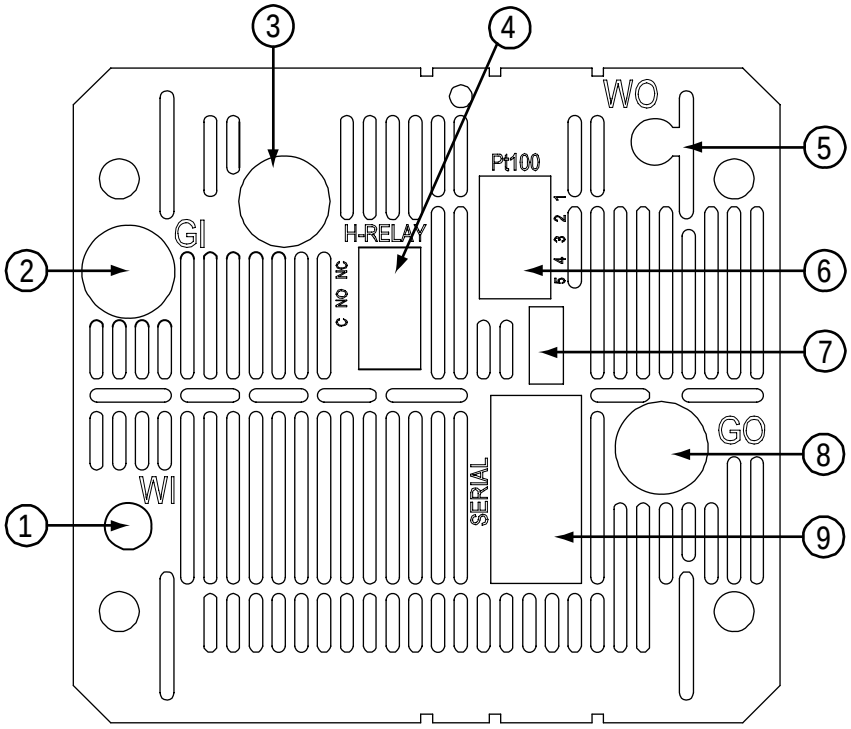

Figure 4 DMP501 Dewpoint Sensing Unit Back Panel

The following numbers refer to Figure 4 above:

1 = Water In (WI)
2 = Gas In (GI)
3 = Connection to DMI500
4 = Relay for heated sample lines
5 = Water Out (WO)
6 = Temperature sensor connection (optional)
7 = Service switch 4: Adjustment enable switch
8 = Gas Out (GO)
9 = Serial port EIA-232, RS232

NOTE	The DM500 shall always be operated in horizontal position or in position where the device is supported by the handle, see picture on page 125.

Optional Accessories and Spare Parts

Description	Order code
Accessories	
Rack mounting kit	DM500RMP
Portability kit	DM500PAK
Extension cable 2.5 m	DM500ECS
Extension cable 10 m	DM500ECL
Mains EURO	6543
Mains UK	210548
Mains US/Japan	210547
Mains AUS	210619
Spare Parts	
PTFE coated O-ring at gas inlet	210493

Factory Calibration and Service

WARNING Please note that there are no user-serviceable parts inside the DMP501 or DMI500. To avoid safety risks with hazardous voltage or hazardous energy, the enclosures shall not be opened except by authorized Vaisala service personnel.

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CHAPTER 3

FUNCTIONAL DESCRIPTION

This chapter describes the functionality of the product.

DM500 Principle of Operation

DM500 is an automatic, continuously controlling condensation hygrometer designed to measure dewpoint temperatures from -75 ºC to +60 ºC, depending on the model. The system consists of the DMP501 dewpoint sensing unit and the DMI500 user interface unit. The measured gas flows through the sensing unit, where it contacts a temperature controlled quartz surface. The quartz surface is monitored for the presence of condensation. The presence or absence of condensation is sensed using surface acoustic wave (SAW) technology. In the measuring mode, the temperature of the quartz surface is varied until condensation exists in equilibrium. Temperature of the sensor element is measured with a temperature sensor (1/3 DIN B, Pt100, 4-wire) bonded on the backside of the quartz substrate. This measured value is used to accurately output the dew/frostpoint temperature.

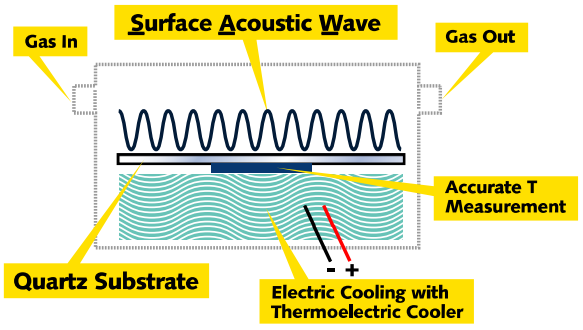

Figure 5 DM500 Operating Principle Illusrated

Sensing Element

The DEWCAP® SAW sensor, as used in the condensation hygrometer, integrates the cooled surface (where condensation forms) with the detection mechanism in one element. The element consists of a transmitting and a receiving antenna photolithographically patterned on a single mechanically very durable crystal quartz chip.

RF-Signal

A radio frequency (RF) signal fed to the transmitting antenna is converted to a micromechanical wave. The mechanical wave propagates along the sensing element surface to the receiving antenna, where the mechanical wave is re-converted to a RF-signal. As the wave propagates at the sensor surface only, it is very sensitive to condensation in contact with the surface.

The presence of liquid condensation on the element alters the signature in a repeatable way. The freezing of the condensation on the element causes a distinctly different signal change, thus enabling the determination of whether dew or frost is on the element.

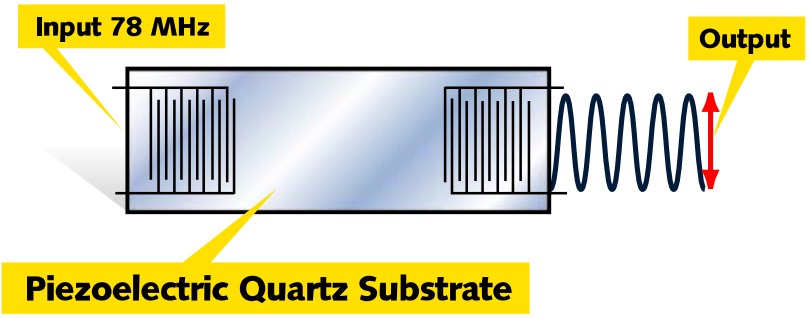

Figure 6 RF-Signal Input/Output Illustrated

Analysis of the received wave in terms of frequency and amplitude provides the information required to control the element's temperature in such a way that a thin layer of dew or frost remains in equilibrium on the element. Additionally, analysis can determine the presence or absence of hygroscopic contaminants on the element.

Hygroscopic dirt like salt is a common source of error in conventional dewpoint measurement techniques. The DEWCAP? sensor can detect the presence of salts on the sensor surface. The salt sensing self-diagnostics can be turned on/off by the user.

Contamination and Chemical Resistance

The DM500 operates reliably even with substantial particulate contamination on the sensing element. Analysis of frequency and impedance makes it possible to distinguish between frost and dew and to give warning of hygroscopic contaminants on the detector.

Use of a quartz wafer as a sensor substrate results in excellent resistance to aggressive chemicals. Wetted parts inside the DMP501 dewpoint sensing unit are limited to stainless steel, silicone, tantalum, quartz, Vectra® (Liquid Crystal Polyester).

Vectra and silicone parts as well as those optional components that have water-absorbing materials are located downstream from the active area of the sensor thus not disturbing the measurement especially in low dewpoints.

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CHAPTER 4

GENERAL INFORMATION ABOUT SAMPLING AND RESULTS

This chapter provides you with useful information concerning gas sampling and the effects that different parameters have on the measurement results.

Gas Sampling

When measuring low dewpoints, all installations must comply with the strict requirements. Clean environment is always beneficial for humidity measurements, but this is especially critical at very low humidities. It is important to use high quality stainless steel tubes (electropolished), particularly clean and dry. Contamination has often a hygroscopic effect. Attention must be paid to correct and tight gas connections. The ambient temperature and the temperature of all parts of the sampling pathway must be kept above the dewpoint to avoid condensation.

The following recommendations shall be taken into account when measuring in very dry environments.

- Minimize the number of connections to avoid leaks
- Ensure that flow rate is adequate
- Avoid dead ends as they cannot be flushed easily
- The temperature of the gas line components must never lie under the dewpoint of the sample gas, as this leads to condensation and false results

- Sample tubing shall be as short as possible, the surface area should be minimized by using the tubing with the smallest diameter that the flow conditions shall permit
- Surface finishing of wetted surfaces is important, polished or electropolished steel is recommended for best results
- Avoid hygroscopic materials in the sampling lines, use stainless steel membranes instead of rubber membranes
- Choose impermeable materials to avoid inward diffusion of moisture through sampling tubes and enclosures, such impermeable materials include high quality stainless steel and metals. Avoid PVC or nylon tubes !
- PTFE (Teflon) tubes are not suitable for dewpoints below -40 ºC.

Measuring in Overpressure

When sampling in pressurized processes, the pressure difference between the gas inlet and outlet ensures gas flow to the sensor.

However, please take into account the following:

- The dewpoint is measured always in the actual pressure. The pressure is released at the flowmeter valve after the sensor chamber. When measuring at overpressure, it must be taken into account that the volume flow rate decreases under pressure, whereas mass flow rate remains constant.
- The pressure ranges of the optional parts are:
    - Integrated pressure sensor: 0...2 bar or 0...20 bar
    - Integrated flow sensor: 1.7 bar

The Effect of the Ambient Temperature on Cooling Capacity

The cooling capacity of the sensor is dependent on the cooling air temperature, as shown in Figure 7. In general, the cooler the ambient air is, the lower dewpoint can be reached. By using air as a cooling medium, the lowest normally achievable dewpoint is about -50 ºC. When measuring lower dewpoint, water cooling must be used. Recommended air temperature: 10...40 ºC (50...104 ºF), depending on the measured dewpoint.

Water cooling is recommended when measuring dewpoints > +40 ºC (+104 ºF).

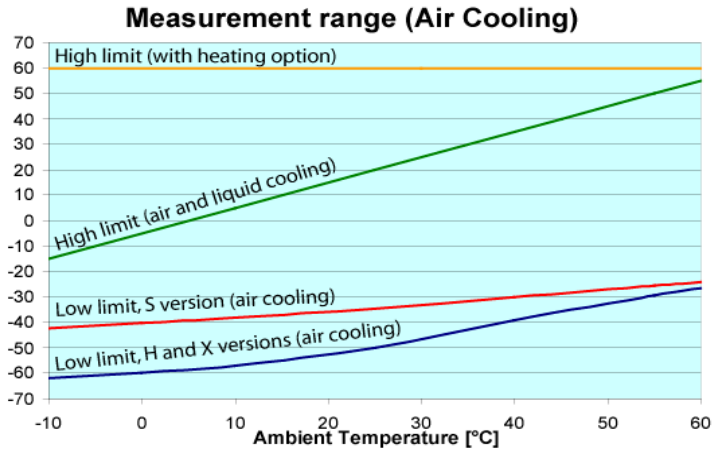

Figure 7 Effect of Ambient Air Temperature on Lowest Achievable Stable Sensor Temperature

The Effect of the Liquid Coolant Temperature on Cooling Capacity

The cooling capacity of the sensor is dependent on the cooling water temperature, as shown in Figure 8. Recommended water temperature: < 15 ºC (50 ºF).

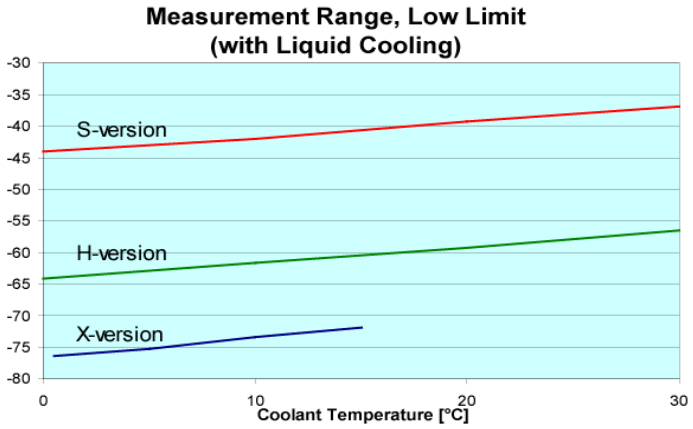

Figure 8 Effect of Water Temperature on Lowest Achievable Stable Sensor Temperature

Sample gas flow in the above Figure 8 1.0 slpm; T_{amb} 23 ºC; water flow 5 l/min.

The Effect of the Sample Gas Flow Rate on Cooling Capacity and Result Deviation

The cooling effect of the gas flow rate is shown in Figure 9 (on the right). Low flow rate increases cooling capacity but also increases response time.

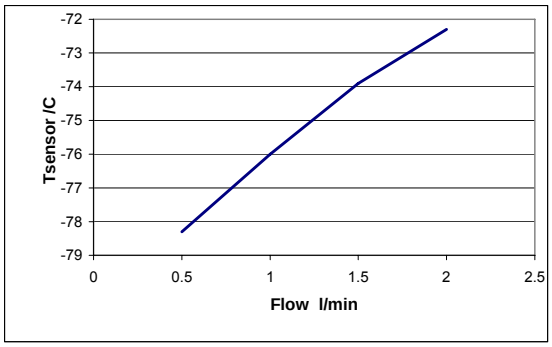

Figure 9 **Effect of Sample Flow Rate on Lowest Achievable Sensor Temperature**

The sample flow rate has an effect on the deviation of the measurement results as shown in Figure 10 (on the right).

Sample flow rate range: 0.5...1.5 slpm.

Recommended sample flow rate: 1.0 slpm.

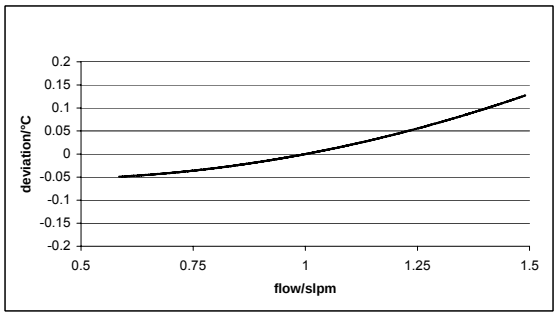

Figure 10 **Effect of Sample Flow Rate on Dewpoint Measurement at -60 °C**

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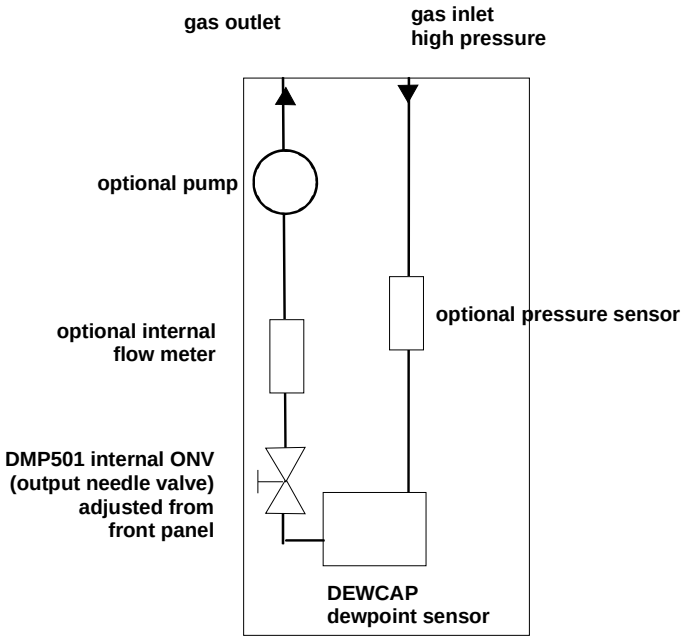
CHAPTER 5

INFORMATION ON OPTIONAL PARTS

This chapter provides you with information on the optional parts of the DM500.

The following optional parts are available for the DM500:

- Heated gas tubes (internal)
- External temperature sensor
- Sampling pump
- Pressure sensor
- Flowmeter



Optional Heated Gas Tubes

Heated gas tubes shall be used if the measured dewpoint is high, close or above ambient temperature. It is recommended to use heated gas tubes already for dewpoints 5 ºC (9 ºF) below ambient temperature.

Internal gas tubes

The optional heated gas tubes keep the internal gas tubes and sensor chamber temperature above 60ºC.

External gas tubes

The heating of the external gas tubes shall be taken care by the user. The external lines shall be heated before letting the sample gas flow in the lines. This is to avoid condensation problems. To facilitate external gas line heating control, the relay output on the back plate of the DMP501 activates when heating is ON. In order to keep the gas connections warm enough the external gas line should be heated 100ºC above ambient and the connections shall be insulated. The maximum dewpoint measurable with the heated internal gas sampling is 35 ºC above the ambient temperature.

NOTE	After switching on the heating option, allow the system to warm up at least 30 minutes to ensure that no condensation occurs in the gas tubes.

WARNING	When heater function is activated, don't touch with bare fingers the hot cap of the sensor chamber. Please use gloves when detaching the cap.

Optional External Temperature Sensor

The external temperature sensor option is needed for temperature or relative humidity (%RH) measurements.

Temperature measurement range	-40…+80 °C (-40…+176 °F)
Typical accuracy	±0.1 °C (±0.18 °F)
Sensor	Pt100 PRT DIN IEC 751 class ¼ B
Cable length	2 m/5 m/10 m

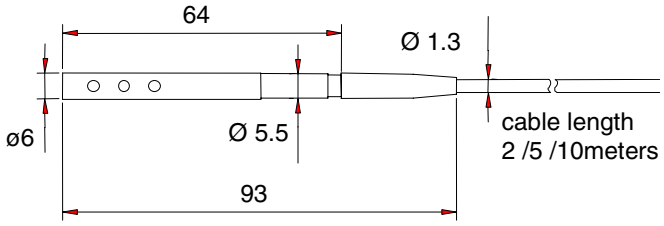


Figure 11 Mechanical Dimensions (in mm) for Optional Temperature Sensor

Wetted Materials of the Optional Parts

Pump	Polyarylamide, NBR (nitril butyl rubber), galvanized steel.
Integrated pressure sensors	Stainless steel (AISI 316)
Integrated flow sensor	Silicon nitride, polyethermide, fluorocarbon, aluminium, oxide, epoxy, silicon, gold
External temperature sensor	Glass, stainless steel, silicone

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CHAPTER 6

SETTING UP FOR OPERATION

This chapter provides you with information that is intended to help you set up the product for operation.

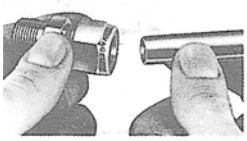
Connection of the DMI500 and DMP501 Units

Unpack the instrument carefully and check that all parts are visually undamaged.

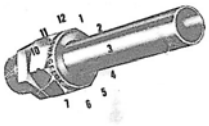
Connect the DMP501 dewpoint sensing unit to the DMI500 user interface unit as follows:

- Insert the male connector at the end of the DMP501 power cable (see Figure 2 on page 16, item 1) into the female connector on the back panel of the DMI500 unit. Tighten the sleeve nut (and simultaneously press the connector in) until the connectors are perfectly mated. If the sensing unit is not connected properly, lines replace the measured values on the display.
- Connect the serial output cable, analog output data cable (back panel of the DMI500) and relay connections (back panel of the DMI500), when used. See the ports from page 17 *Back Panels*.
- Connect the DMI500's grounded power supply cable (provided) to the grounded box.

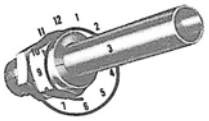
Swagelok tube fittings' installation instructions



1. Insert the tubing into the Swagelok tube fitting. Tubing should rest firmly on the shoulder of the fitting. The nut should be finger tight.



2. Mark the nut at the 6 o'clock position.
3. Hold the fitting body with a backup wrench and tighten the nut 1¼ turns. Watch the marking and make one complete turn and continue to 9 o'clock position.



CAUTION	The DM500 as delivered from the factory has 6 mm Swagelok tube fittings. If you use ¼" tubing, always use the proper ¼" adapter fitting (provided). Make sure the adapter is connected the right way. An incorrectly connected adapter or connecting ¼" tubes straight into the 6 mm tube fittings may lead to product damage. See Figure 12 and Figure 13 for visual instructions.

Figure 12 Standard 6 mm Swagelok Tube Fitting with the Elbow Connector in the DMP501 Back Panel

Figure 12 shows the standard set-up of the DMP501 back panel. Figure 13 illustrates the correct way of connecting ¼" tubing to the 6 mm tube fitting.

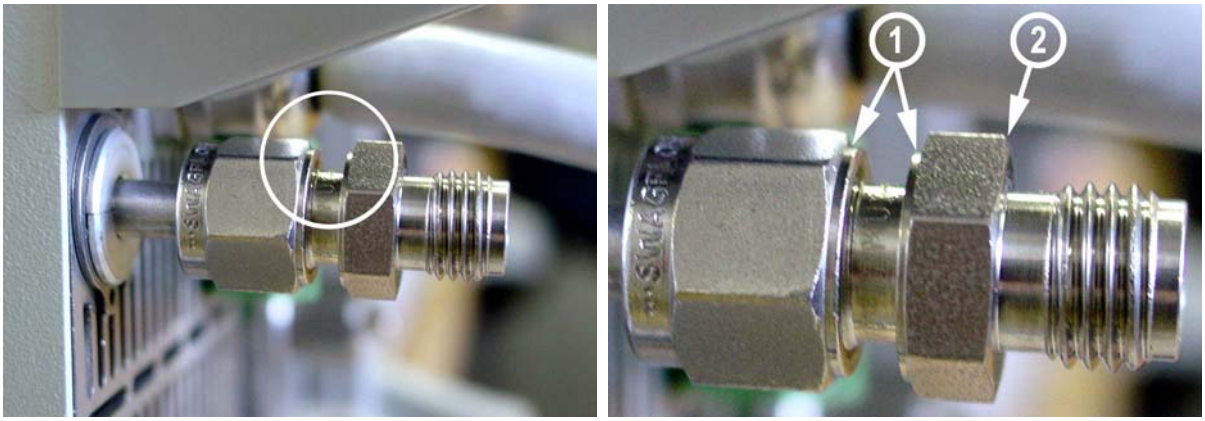


Figure 13 ¼" Swagelok Adapter Fitting Connected to the Standard Swagelok 6 mm Connector

The following numbers refer to the enlarged area of Figure 13 above:

1 = Grooves
2 = No groove

To connect the ¼" adapter fitting, first disconnect the standard elbow fitting. Notice how the millimeter-fittings have small grooves on them. When the grooves face, the adapter fitting is connected the right way. The inch-side of the adapter fitting has no groove on it.

Connecting the Sample Gas Flow

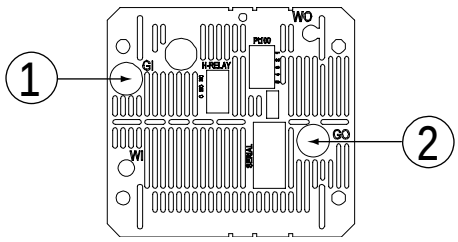


Figure 14 DMP501 Back Panel, Connectors for Sample Gas

The following numbers refer to Figure 14 above:

1 = Gas In (GI)
2 = Gas Out (GO)

1. Detach the Swagelok fittings from Gas In (GI) and Gas Out (GO) connections. If the sample gas can flow out to measuring room, it is not necessary to connect the GO fitting. Replace the

6 mm fitting with the ¼" adapter fitting (provided), if needed. If you use the adapter fitting, see that the 6 mm side is connected to the Gas In -connection.

2. Attach the gas tubes (diameter of 6 mm or ¼") to the Swagelok fittings.
3. Replace the Swagelok fitting (with the tubing) into the GI connector (connect the Gas Out tubing similarly, if necessary).

NOTE	When measuring high dewpoint temperatures with heated lines, the connection fitting shall be insulated carefully to prevent condensation.

4. Let the sample gas flow with a flow rate of 0.5...1.5 slpm (recommended 1.0 slpm)
5. If needed, adjust the sample flow rate by turning the Allen screw (in the sensor cup, see Figure 2 on page 16, item 2) with a key (provided).

WARNING	Do not connect flammable, highly reactive or toxic gases to the instrument. Ensure adequate ventilation when using other gases than air.

Selecting the Cooling Method

Use either air or water in sensor cooling.

- water cooling: generally required when measuring dewpoint below -50 ºC (-58 ºF) and recommended when measuring dewpoints higher than +40 ºC (+104 ºF)

Use of subzero water/glycol or ethanol mixture, as the cooler liquid is not recommended, as there is a risk of substantial ice formation inside the sensing unit. However, subzero cooling liquid can be used for short periods. To ensure sufficient cooling capacity, please follow the instructions below. The temperature of the cooling air/water and flow rate of the sample gas has an effect on the cooling capacity.

When using air cooling, the fan inside the device is cooling the system. When using water cooling, connect the water as instructed in the following chapter.

NOTE	To avoid condensation into the internal gas tubes and sensor, stop cooling water flow if measurement is stopped and T_d of sample gas may be higher than the cooling water temperature.

Connecting the Cooling Liquid

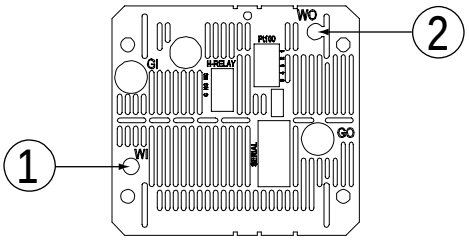


Figure 15 DMP501 Back Panel, Connectors for Cooling Liquid

The following numbers refer to Figure 15 above:

1 = Water In (WI)
2 = Water Out (WO)

1. Remove the Swagelok fittings from Water In (WI) and Water Out (WO) connections.
2. Attach the tubes (diameter of 8 mm) to the Swagelok fittings (diameter of 8 mm or 5/16"). Plastic tubes are recommended.
3. Connect the water inflow tubing to the connector WI. And similarly the water outflow tubing to connector WO. Reverse water flow can be used as well.
4. Replace the Swagelok fittings to the back panel connectors.
5. Let the water flow with the flow rate of 5...20 l/min, temperature of water shall be <+15 ºC (50 ºF). Check for leaks and tighten if necessary.

Once the water tube connections have been tightened, the water tubing should be disconnected from the Swagelok fittings.

Connecting the Condensation Water Drain Tube

Significant moisture condensation occurs only if the system is water-cooled. Connect the condensation water drain tube to the outlet situated on the right-side panel of the DMP501.

1. Connect the silicone tube to the metal tube protruding from the right side of the DMP501 Dewpoint Sensing Unit.
2. The tube end must be placed at least 300 mm below the sensing unit bottom level, in a drain or in a small vessel where the condensed moisture can be safely drained. The amount of condensed moisture is small, typically tens of milliliters per 24 h of operation.

WARNING	Do not assemble the instrument in a location where condensed water dripping out of the system could cause a hazard, such as above high-voltage power supplies.

CHAPTER 7

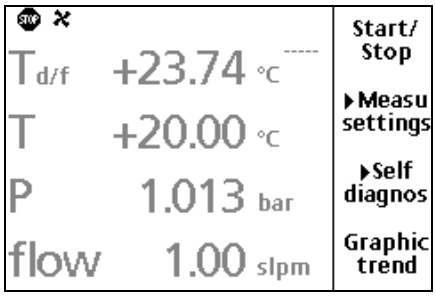
MEASURING THE DEWPOINT

This chapter provides instructions on how to conduct dewpoint measurements with the DM500, and contains additional information about the moisture phases.

Dewpoint Measurement with DM500

Do not assemble the instrument in a location where condensed water dripping out of the system could cause a hazard, like above high-voltage power supplies.

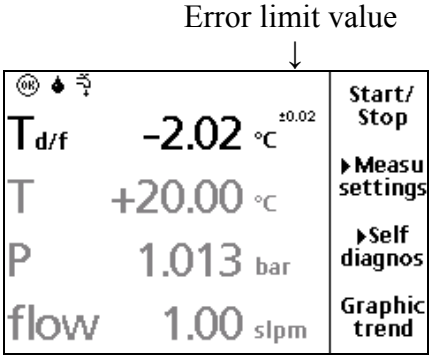
1. After the installation procedures, turn the power on by pressing the power ON/OFF button ⏻.
2. Let the system warm up for at least 1 minute before starting the measurements.
3. When the device is ready for use, the following display appears:



Display before activating the measurement mode

4. Select the water or air cooling method. Press the soft key ⊙ ► Measu settings, select by using arrow button Cooling method. Select WATER 🚰 or AIR 🌬. See page 38, *Selecting the cooling method*.

5. To achieve the optimum measuring results, clean the sensor and determine the clean sensor value before the first measurements, see page 65.
6. Start measurement by pressing ⊙ START/STOP.
7. Wait until yellow led turns to green in the DMP501 dewpoint sensing unit front panel. The ⧖ symbol disappears from the display and the error limit value appears on the upper right corner of the display. The measuring cycle is now balanced. You can follow the stabilization from the graphic trend.



Measurement mode display

8. Droplet symbol ♦ on the upper left corner of the display indicates the presence of dew on the sensor.

If the condensation on the sensor freezes the droplet changes to a snowflake symbol ❄. If the sensor has both dew and frost on the surface, both ♦ and ❄ symbols are displayed. The moment of instability is indicated both by blinking ♦ and ❄ symbols as well as by increased error limit value. The instability period usually lasts less than 10 minutes until the condensation is frozen. Thus, the user need not keep track of the moisture phase in order to obtain reliable measurement results in the temperature range where either dew or frost or both can exist on the sensor (typically 0 ºC...-30 ºC)

More About the Moisture Phases ♦❄

The system detects the phase of the moisture on the sensor automatically and uses this phase data when converting measured sensor temperature to the user selected unit. For example, if the user wishes to output dewpoint, not frostpoint, the system uses the measured sensor temperature as dewpoint temperature as long as the moisture phase remains liquid (♦ symbol in the display). If the dewpoint is low, the sensor may freeze. The system detects the moment of freezing and thereafter considers the sensor temperature to be the frostpoint temperature. This frostpoint temperature is

automatically converted to a corresponding dewpoint temperature, which is then displayed to the user. The symbol on the display changes to ❄ after the freezing is complete.

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CHAPTER 8

DISPLAYS AND MENUS

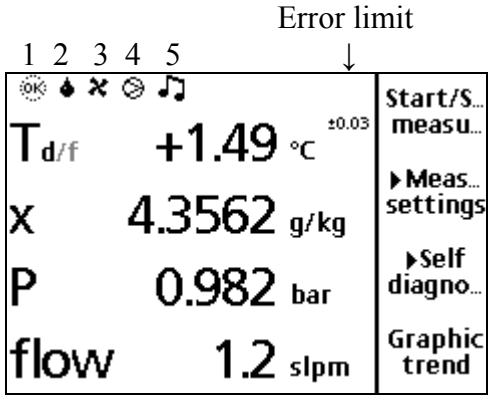
This chapter describes the user interface.

Main View (In Measuring Mode)

Selected quantities:

Displayed in gray = value is set or inactive

Displayed in black = value is measured



Starts/stops measuring

Shortcut to Measuring settings-menu

Shortcut to Self diagnostics-menu

Shows the graphical trend

Figure 16 Main View Display

The following numbers refer to Figure 16 above:

1 = Symbol that indicates if the measuring status: active (OK), stopped (STOP), wait (⧖).
2 = Symbol which indicates the form of the moisture on the sensor ♦ water, ❄ frost.
3 = Symbol which indicates the cooling method, ✕ air, water
4 = Symbol which indicates that optional pump for the sampling line is on. If this symbol is not shown, the pump is off.
5 = Shows that the alarming condition is valid.

Error limit: The 2σ deviation of the measured sensor temperatures.

Appears when the system is balanced and statistical filtering activated. During an unstable intermediate moisture phase indicated by blinking ♦ and ❄ symbols, error limit value is higher than in stabilized state.

Preset value(s): All the preset values are shown in the header if they are not selected for the display.

Values shown in the display in black color are active measured values. Temperature, flow, or pressure values in gray color are preset, not measured. $T_d/T_{d/f}$ are gray showing the sensor temperature when the measurement is in stop mode. Other humidity quantities are not shown in stop mode.

Graphical Display

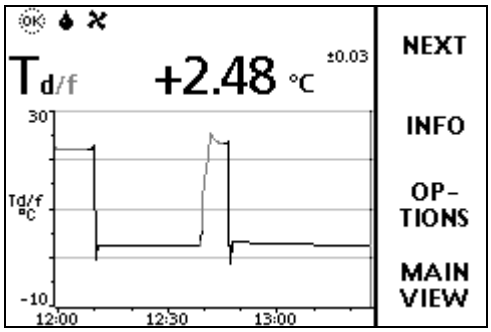


Figure 17 DM500 Graphical Display

Graphical display shows you the measurements in a form of curve. From the curve you can examine the data trend and history of the last few hours.

1. In main view, press ⊙ Graphic trend or (alternatively open the MENU, select ▶ Display-Graphic trend).
2. Graphical display opens. For more information, select the screen Graphical trend.
3. Press ⊙ MAIN VIEW to return to the main view.

More information on graphic trend on page 55.

Menus and Navigation

In the menus you can change settings and select the functions.

1. Open the main menu by pressing any of the ⏶⏷⏵⏴ buttons.
2. Move in the menus by using ⏶⏷ buttons.
3. Select the item with ⏵ button.
4. Press ⏴ to return to the earlier level.
5. Press EXIT to return you back to the main view.

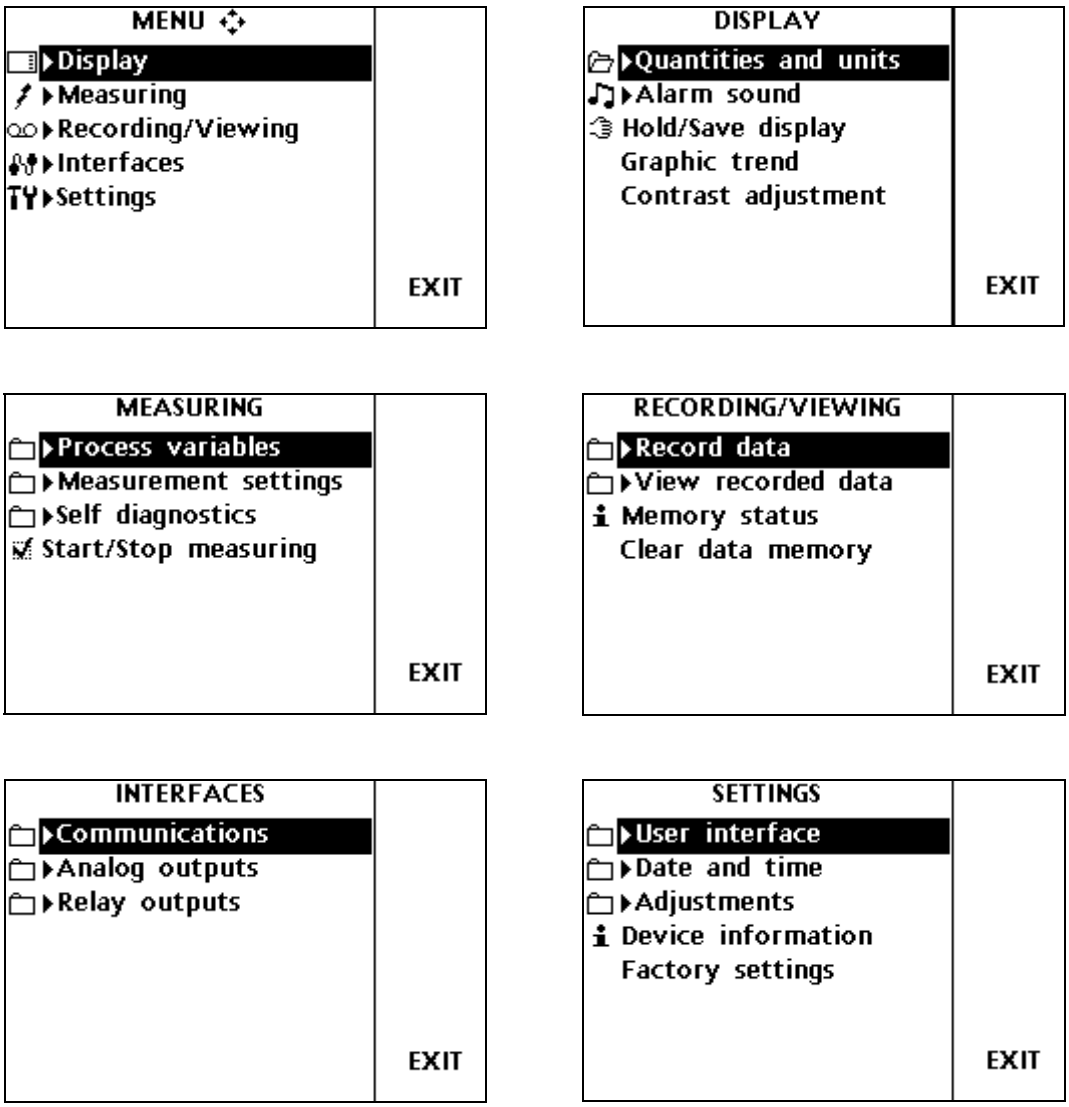


Figure 18 DM500 Menus and Displays

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CHAPTER 9

BASIC SETTINGS

This chapter provides instructions on how to make the basic settings.

User Interface

Setting the Language

1. Open the MENU: press ▷.
2. Select ►Settings, press ▷.
3. Select ►User Interface, press ▷.
4. Select **Language**, press ⊙ SET.
5. Select the language (English/ German/ French/ Finnish/ Spanish) and press ⊙ SELECT.
6. Press ⊙ EXIT to return to the main view.

Changing the Shortcut Keys

As a default, the four shortcut keys refer to the functions Start/Stop, ►Measurement settings, Self diagnostics and Graphic trend. If needed, a shortcut for the functions can be changed according to your needs.

1. Open the MENU: press ▷.
2. Select ►Settings, press ▷.
3. Select ►User Interface, press ▷.
4. Select Program shortcut keys, press ⊙ START.

5. Press the shortcut key you want to change, for example ►Measurement settings.
6. Select the new shortcut function by using arrow buttons, press ⊙ SELECT. Answer YES to confirm your selection, otherwise answer NO and continue from item 4.
7. Press ⊙ EXIT to return to the main view.

Key Click ON/OFF

You can turn the button pressing sound effect on or off.

1. Open the MENU: press ⓓ.
2. Select ►Settings, press ⓓ.
3. Select ►User interface, press ⓓ.
4. To turn on or off sound effect while pressing the buttons, select Key Click and press ⊙ ON/OFF.
5. Press ⊙ EXIT to return to the main view.

Setting Date and Time

Open the MENU: press ⓓ.

6. Select Setting, press ⓓ.
7. Select Date and time, press ⓓ.
8. The default date presentation format is year-month-day, for example 2001-11-01. To change the date, select Date and press ⊙ SET. Change the date by using arrow buttons or numerical buttons. To confirm the date, press ⊙ OK. If you want to change the format, select Date format, press ⊙ SET. Select the other date format *month/day/year* or *date.month.year*), press ⊙ SELECT.
9. The default time presentation format is 24-hour clock. To change the time, select Time and press ⊙ SET. Change the time by using arrow buttons and numerical buttons. To confirm the time, press ⊙ OK. If you want to change the format, select 12-hour clock, press ⊙ ON/OFF.
10. Press ⊙ EXIT.

Device Information

The basic information about the DM500 is found as follows:

1. Open the MENU: press ⓑ.
2. Select ▶Settings, press ⓑ.
3. Select Device information, press ⊙ SHOW.
4. The display gives the basic information on the device. Press ⊙ OK, ⊙ MORE to get more information and ⊙ EXIT to return to the main view.

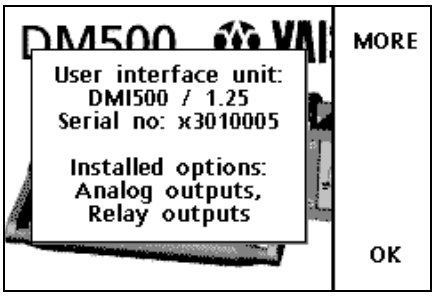

Figure 19 DMI500 User Interface Unit Information

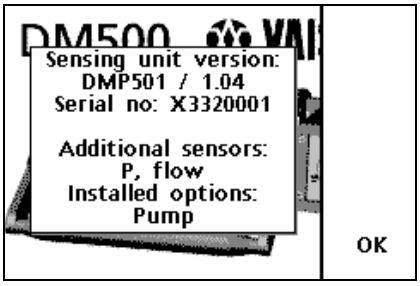

Figure 20 DMP501 Dewpoint Sensing Unit Information

Reverting Factory Settings

Factory settings can be reverted to clear all changed settings and data memory. Reverting factory settings does not affect sensing unit calibration.

1. Open the MENU: press ⓓ.
2. Select ▶Settings, press ⓓ.
3. Select Factory settings, press ⊙ REVERT. Press ⊙ YES to confirm the reverting.
4. The device resets automatically.

CHAPTER 10

DISPLAY SETTINGS

This chapter describes the display settings.

Display Backlight

The display backlight is automatically on when the device is turned on. After 10 hours use, the backlight turns off. When pressing any button, the light turns on again.

Selecting the Quantities and Units

The following quantities and units can be chosen to the display:

Parameter	Unit
$T_{d/f}$, T_d	ºC or ºF
[2] P_w (water vapor partial pressure)	mbar
[2] H_2O (water content in ppm_v)	ppm_v
[12] RH (relative humidity)	%RH
[12] T_w (wet-bulb temperature)	ºC or ºF
[12] a (absolute humidity)	g/m^3, gr/ft^3
[2] a_{NTP} (absolute humidity in NTP conditions)	g/m^3, gr/ft^3
[2] x (mixing ratio)	g/kg, gr/lb
[12] h (enthalpy)	kJ/kg, Btu/lb
[1] ºT (difference of T and $T_{d/f}$)	ºC or ºF
[1] T (temperature)	ºC or ºF
[2] P (pressure)	bar, hPa, psi, torr
[3] Flow	slpm, scfh

[1] If sampling from process, parameter is relevant only if the optional temperature sensor is used to measure real temperature of the process gas (or if the actual T value is set manually).

[2] If sampling from process, parameter is relevant only if the optional pressure sensor is used.(or if the actual P value is set manually)

[3] If sampling from process, parameter is relevant only if the optional flow sensor is used (or if the actual Flow value is set manually).

More about the difference between Td/f and Td on page 128.

To select the displayed quantities:

1. Open the MENU; press ▷.
2. Select ▶Display, press ▷.
3. Select ▶Quantities and units, press ▷
4. Select the quantity you want by using the arrow buttons, press ⊙ SELECT.
5. Select and change similarly the other quantities and units. Four quantities can be chosen for the display.
6. Press ⊙ EXIT to return to the main view.

NOTE	When changing the unit via the serial line, the display unit changes simultaneously, see command UNIT.

Hold/Save Display

Hold/Save function enables you to freeze a certain display reading. This reading can be saved into the memory as a single data point.

1. Open MENU: press ▷.
2. Select ▶Display, press ▷
3. Select Hold/Save display, press ⊙ HOLD to freeze the display. The frozen measurement data is displayed.
4. Press ⊙ SAVE to save the reading or ⊙ EXIT to return to the main view.
5. You can save several readings with HOLD-SAVE function. All the individually saved readings are stored in a same file marked with and a start date.

6. To view the saved readings, open the menu, select Recording/Viewing, press ▷, select View recorded data, press ▷.
7. Select the file marked with , press ⊙ SHOW. Now you can see the firstly saved data reading on the display numerically and pointed out in graphics with a vertical line (the curve shows all the individual data points). Press ▷ to see the next data point numerically etc. The saving times of individual data points are shown in the first row of the display, after the date.
8. Press ⊙ NEXT to see the other parameters (temperature, pressure and flow).
9. Press ⊙ INFO to see the statistics of the saved data points.
10. Press ⊙ OPTIONS to set the following graph options:

    Show value: Select ⊙ YES to have the data points shown numerically. Select ⊙ NO to hide the numerical value.

    Hide function keys: Select ⊙ YES to hide the function keys shown in the right side of the display. Select ⊙ NO to have the function keys shown.

    Automatic scale: Select YES to have the y-axis scaled automatically. Select NO to have the y-axis scaled manually. To set the scaling manually, select with the arrow button the Min and Max values and change the values by using the numerical buttons. If you set manually impossible values (for example min > max), the automatic scaling is forced to the on state.

11. Press ⊙ BACK and ⊙ EXIT to return to the main view.

All the individual Hold/Save data points are saved in the same file until the power is switched off. When switching on again and saving data, the data points are saved in a different data file.

Graphic Trend

Graphic trend shows you the data curve from the time turning on the device.

1. Open MENU: press ▷.
2. Select ►Display, press ▷
3. Select Graphic trend, press ⊙ SHOW.

4. Press ⊙ NEXT to see the graphic trend of the other parameters.
5. Press ⊙ INFO to see the statistics of the saved data.
6. Press ⊙ OPTIONS to set the following graph options

   Show value: Select ⊙ YES to have the data shown numerically. Select ⊙ NO to hide the numerical value.

   Hide function keys: Select ⊙ YES to hide the function keys shown in the right side of the display. Select ⊙ NO to have the function keys shown.

   Automatic scale: Select ⊙ YES to have the y-axis scaled automatically. Select ⊙ NO to have the y-axis scaled manually. To set the scaling manually, select with the arrow button the Min and Max values and change the values by using the numerical buttons. If you set manually impossible values (for example min > max), the automatic scaling is forced to the on state.

7. To zoom in the curve, press the arrow button ⍓. To zoom out, press the button ⍗. To select the individual data points from the curve, press either of the buttons ⍈⍇.
8. Press ⊙ MAIN VIEW to return to the main view.

Contrast Adjustment

You can change the contrast of the LCD display using the Contrast adjustment.

1. Open MENU: press ⍈.
2. Select ▶Display, press ⍈.
3. Select Contrast adjustment, press ⊙ START.
4. To increase the contrast, press ⊙ DARK.
5. To decrease the contrast, press ⊙ LIGHT.
6. Press ⊙ OK and ⊙ EXIT to return to the main view.

Alarm Sound

DM500 alarms by beeping and blinking the display. You can select the alarm quantity and set the alerting set points. The alarm function can be enabled also on the basis of the measurement status. If there are no set points selected, measurement status controls the alarm.

1. Open MENU: press ⊳.
2. Select ►Display, press ⊳.
3. Select Quantity, press ⊙ SET , select the quantity for the alarm and press ⊙ SELECT.
4. Select Alert above, press ⊙ SET. (In case you want to delete the setpoint, press ⊙ DELETE and go to item 6).
5. Press ⊙ CLEAR and give the value by using numerical buttons. Press ⊙ OK.
6. Select Alert below, press ⊙ SET. (In case you want to delete the setpoint, press ⊙ DELETE and go to item 8).
7. Press ⊙ CLEAR and give the value by using numerical buttons. Press ⊙ OK.
8. Select ENABLED WHEN, press ⊙ SELECT. Now you can select the measurement status that activates the alarm.

STOP: alarm is enabled when dewpoint measuring status is STOP.

ERR: alarm is enabled when dewpoint measuring status is ERR.

OK: alarm is enabled when dewpoint measuring status is OK

WAIT: alarm is enabled when dewpoint measuring status is WAIT

All the modes selected: alarming is not dependent on any measurement status (only on numeric set points).

None of the modes selected (never): alarming is disabled.

You can select any combination of the measurement status to control the alarm.

9. Press ⊙ OK and ⊙ EXIT to return to the main view.

Alarming

The display is beeping and blinking and the note sign message is shown in the display. Mute the alarming by pressing ⊙ MUTE and ⊙ OK. If the alarming condition is still valid a small note sign remains in the header of the display. The note sign disappears when the alarming condition is not valid anymore.

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CHAPTER 11

MEASUREMENT SETTINGS

This chapter provides you with information about the measurement settings.

Automatic Frost Detection

The automatic dew/frost sensing procedure senses if the condensation on the sensor is water (dew) or ice (frost). If the sensing is turned off, the $T_{d/f}$ value can be either dewpoint or frostpoint, depending on the sensor state. Then the other water content quantities are disabled. If the sensing is on (default), the $T_{d/f}$ value below temperature of 0 ºC/32 ºF is always frostpoint.

1. Open MENU: press ⓓ.
2. Select ►Measuring, press ⓓ
3. Select ►Measurement settings, press ⓓ.
4. Select Autom.frost detection.
5. To enable the sensing, press ⊙ ON.
6. To disable the sensing, press ⊙ OFF.
7. Press ⊙ EXIT to return to the main view.

NOTE	Cleanliness of the sensor is essential for the proper operation of frost detection.

Forced Freezing

In some measurement conditions there may be formation of a two phase system, ice-dew, on the sensor. This situation is dynamic and the time needed to reach an equilibrium may be rather long. To avoid an unstable phase transition, the DM500 has a function for generating a stable layer of frost on the sensor right from the beginning of the measurement.

When turned on, the forced freezing procedure is automatically enabled when measurement is started. However, the forced freezing procedure may also be turned off by the user, if so desired.

The automatic forced freezing procedure recognizes the temperature at which condensation begins to form on the sensor surface. The control of the forced freezing procedure is based on this temperature, and therefore the dewpoint of the measured gas should be stable during the freezing procedure. If forced freezing is enabled and the frostpoint is ca. -6...-30 ºC, the procedure will freeze the sensor cold enough for the condensation to form a stable layer of frost. Use of forced freezing may lengthen the measurement start-up time.

If forced freezing is disabled by the user, in certain conditions formation of an unstable phase system on the sensor is possible.

1. Open MENU: press ▷.
2. Select ►Measuring, press ▷
3. Select ►Measurement settings, press ▷.
4. Select Forced freezing.
5. To enable the function, press ⊙ ON.
6. To disable the function, press ⊙ OFF.
7. Press ⊙ EXIT to return to the main view.

Cooling Method Air/Water

Select the cooling method air (✕) or water (🚰) by using this function. Water cooling is recommended when measuring dewpoints below -50 ºC (-58 ºF) or above +40 ºC (104 ºF).

This selection optimizes the operation of thermoelectric coolers.

NOTE	Select the water cooling only if the water is actually supplied to the sensing unit. Otherwise the sensing unit can be overheated

To select the cooling method:

1. Open MENU: press ▷.
2. Select ►Measuring, press ▷.
3. Select ►Measurement settings, press ▷.
4. Select Cooling method.
5. To select air cooling, press ⊙ AIR.
6. To select water cooling, press ⊙ WATER.
7. Press ⊙ EXIT to return to the main view.

More information about selecting the cooling method on page 38.

Statistical Filtering

The statistical filtering is on as default. When the filtering is on, the dewpoint reading is changing in steps and the statistical uncertainty value is calculated for each reading and the statistical error limit is shown in the display. If the filtering is turned off, the reading shows the trend of the sensor temperature variation in real time. Thus, changes in humidity can be seen more rapidly but the error limit is not shown in a display.

1. Open MENU: press ▷.
2. Select ►Measuring, press ▷.
3. Select ►Measurement settings, press ▷.
4. Select Statistical filtering, press ⊙ OFF.
5. Press ⊙ EXIT to return to the main view.

The statistical filtering can also be turned on/off by using serial command **ANAL**, see serial commands.

Response Speed

You can set the response speed to stable, normal (default) or fast. If fast transients in the dewpoint prevent the system from reaching balance, the signal can be stabilized by selecting the Stable response speed. Fastest response time is achieved by setting the speed to Fast but this may increase the noise in the dewpoint measurement. As a rule of thumb, always use the fastest setting that gives stable readings!

1. Open MENU: press ⓓ.
2. Select ▶Measuring, press ⓓ.
3. Select ▶Measurement settings, press ⓓ.
4. Select Response, press ⊙ SET.
5. Select one of the following options:

   Stable: Press ⊙ SELECT to have the slowest response speed.

   Normal: Press ⊙ SELECT to have normal response speed.

   Fast: Press ⊙ SELECT to have fast response speed.
6. Press ⊙ EXIT to return to the main view.

Pump ON/OFF

1. Open MENU: press ⓓ.
2. Select ▶Measuring, press ⓓ.
3. Select ▶Measurement settings, press ⓓ.
4. Select Pump, press ⊙ ON/OFF.
5. Press ⊙ EXIT to return to the main view.

Transient Recovery Time

The transient recovery time is the time the sensor waits before starting the fast recovery cycle after rapid dewpoint change. If there are large, rapid step changes in humidity level the shorter transient recovery times are recommended. If the changes are slow (like typically at low dewpoints), the longer transient recovery times are recommended. Selecting the Off option turns the transient recovery time function off, meaning that after rapid dewpoint change the fast recovery cycle will not be initiated.

NOTE	It is not recommended to turn Off the transient recovery time function. If there are large, rapid dewpoint changes and the transient recovery time function is off, the response time may be hours.

1. Open MENU: press ▷.
2. Select ►Measuring, press ▷.
3. Select ►Measurement settings, press ▷.
4. Select Transient recov., press ⊙ SET.
5. Select one of the following options, press ⊙ SELECT.

   20 s, 60 s, 2 min (default), 5 min, 15 min, Off.
6. Press ⊙ EXIT to return to the main view.

Setting the Temperature, Pressure, and Flow Values

In case the device does not have the optional temperature, pressure and flow sensors, the fixed manually fed values (e.g. for calculations) are given as follows:

1. Open MENU: press ▷.
2. Select ►Measuring, press ▷.
3. Select ►Process variables, press ▷.
4. Select the parameter you want to change by using the arrow buttons.
5. Press ⊙ CLEAR to clear the old value.

6. Set the new value by using numerical buttons.
7. Press ⊙ OK to confirm the settings.
8. Press ⊙ EXIT to return to the main view.

The Process variables selection menu is only available for those parameters that are set, not measured.

CHAPTER 12

SELF DIAGNOSTICS SETTINGS

This chapter describes the self diagnostic functions settings. The DM500 goes through a self diagnostics procedure when the power is switched on. If an error is found, the error display tells about it. However, there are some self diagnostics operations that the user can set, such as Salt detection, Sensor circuit check and Cooling capacity test.

Salt Detection

During the salt detection function the wet sensor impedance is detected to see if there is hygroscopic contamination on the sensor. The clean sensor value (salt detection limit) is checked as reference. Therefore, please clean the sensor always before determining the clean sensor value. The clean sensor value is preset at the factory, but re-determination by the user is recommended for optimum results.

The **automatic salt detection** is off as a default. You can turn it on by setting the interval and salt detection limit. The **manual salt detection** can be done to check if the sensor is clean.

Salt detection works only when there is dew on the sensor. Frostpoint measurement is very little affected by hygroscopic contaminants, due to the limited mobility of the ions. Consequently, a typical effect of hygroscopic contamination on measurements is a large positive offset that appears after the moisture phase on the sensor changes from frost to dew.

The salt detection, as well as the clean sensor value determination require a gas flow with dewpoint above 0º C through the sensing unit. Lower dewpoints can also be used as long as the moisture phase remains liquid.

If the salt detection sees salt on the sensor (message on the display), please clean the sensor carefully, see page 113. The salt warning message is shown when the measured value decreases below 80 % of the salt detection limit. It is not recommended to use serial commands during the salt detection. Salt detection interrupts the dewpoint measurement for approximately one minute.

The salt detection function is enabled as follows:

1. Open MENU: press ▷.
2. Select ▶ Measuring, press ▷.
3. Select ▶ Self diagnostics, press ▷.
4. Select ▶ Salt detection.
5. To enable the automatic sensing, select Autodetect interval, press ⊙ SET and give the salt sensing interval (1...99 h) by using the numeric buttons.
6. Press ⊙ OK.
7. Carry out this step only if you want to determine the clean sensor value after cleaning.

   Select Clean sensor value, press ⊙ DETERMINE. In this stage, the system measures the salt detection limit (clean reference). To disable the automatic sensing, press ⊙ OFF.
8. To start the manual salt sensing test, select Manual salt sensing and press ⊙ START.
9. Press ⊙ EXIT to return to the main view.

Sensor Circuit Check

During the sensor circuit check the sensor is heated up and the propagation of the RF-signal through the circuit is checked. If the system is not operating as expected the error message is shown, see page 115, *Error Messages*. The sensor circuit check also re-calculates the transmission for a dry sensor, thus performing contamination compensation.

Sensor circuit check is performed automatically each time when the measuring is started. During the measuring, the periodical checking is not done (default) unless the automatic sensor circuit check is turned on by setting the interval. In case there is a need for checking the operation of the sensor periodically, or if automatic dry-out cycle for

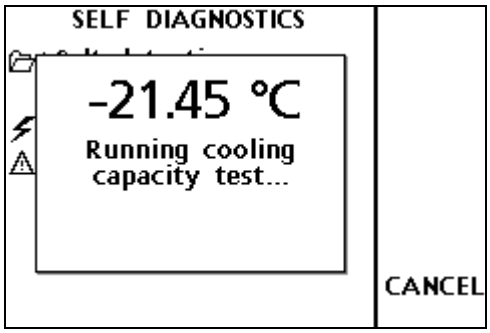
the sensor is desired, you can set the automatic checking interval (1...99 h) as follows:

1. Open MENU: press ⓑ.
2. Select ►Measuring, press ⓑ.
3. Select ►Self diagnostics, press ⓑ.
4. Select Sensor circuit chk.
5. To turn on the sensor checking circuit and set the checking interval, press ⊙ SET.
6. Set the interval (1...99 h) by using the numerical buttons.
7. Press ⊙ OK to confirm the setting. Now the automatic sensor circuit check will be done in determined intervals.
8. If needed to turn off the checking operation, press ⊙ OFF.
9. Press ⊙ EXIT to return to the main view.

Cooling Capacity Test

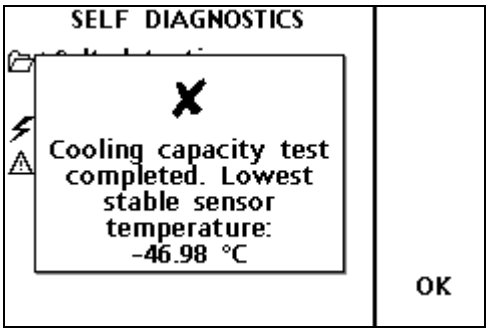
In the cooling capacity test the sensor is cooled to the lowest possible temperature. The measurement mode must be stopped during the cooling capacity test.

1. Open MENU: press ⓑ.
2. Select ►Measuring, press ⓑ.
3. Select ►Self diagnostics, press ⓑ.
4. Select Cooling capacity test
5. Press ⊙ START to start the test. The test may take up to 20 min. During that time the measuring is stopped and you can follow the actual temperature of the sensor from the display:



The serial output command **R** shows frozen values. You can cancel the testing sequence by pressing the ⊙ CANCEL.

6. When the test is completed, you see the following display:



7. Press ⊙ EXIT to return to the main view.

The following factors affect the cooling capacity:

- Temperature of the environment
- Temperature of the cooling water and
- Gas flow rate of the sample.

Please, check that these settings are correct, see chapter *Setting up for Operation*, page 35. The graphs on pages 27 and 29 show the lowest achievable sensor temperatures. In addition, to obtain correct results, the test should be started with the system at equilibrium with room temperature.

Error History

The error history shows on the display six last shown error messages.

1. Open MENU: press ⊙.
2. Select ▶ Measuring, press ⊙.
3. Select ▶ Self diagnostics, press ⊙.
4. Select Error history.
5. Press ⊙ SHOW to see the last shown error display. Press ⊙ NEXT to see the earlier ones.
6. To clear the error history, press ⊙ CLEAR.
7. Press ⊙ EXIT to return to the main view.

CHAPTER 13

RECORDING DATA

This chapter provides instructions on data recording with the DM500.

Data Recording

You can record measurement data and view the recorded data on the display.

1. Open MENU: press ▷.
2. Select ▶Recording/Viewing, press ▷.
3. Select ▶Record data, press ▷.
4. Select Interval, press ⊙ SET.
5. Set the measurement interval by selecting the interval time by using the arrow buttons, press ⊙ SELECT. See the table below. Note, you can not set longer interval than the measurement duration !
6. Set the measurement duration (5 min, 15 min, 30 min, 1 hours, 3 hours, 12 hours, 24 hours, 7 days, 30 days, memory full) by selecting Duration, press ⊙ SET. Note the maximum recording durations are based on the measurement interval !
7. To start recording, select Start/Stop recording, press ⊙ START. The progress bar  is shown on the display showing the amount of recorded data.

Interval	Max. recording duration (memory full)
5 s	68 min
15 s	3 h
30 s	6 h
1 min	13 h
5 min	68 h
15 min	8 d
30 min	17 d
1 hour	34 d
3 hours	102 d
12 hours	409 d

Stopping Recording

1. Open MENU: press ⓓ.
2. Select ►Recording/Viewing, press ⓓ.
3. Select ►Record data, press ⓓ.
4. To stop recording, select Start/Stop recording and press ⊙ STOP.
5. Now you can go and see the recorded file by selecting ⊙ SHOW.

Viewing Recorded Data

When viewing the recorded data, firstly choose for the main view the quantities you want to view. Then follow the instructions below.

1. Open MENU: press ⓓ.
2. Select ►Recording/Viewing, press ⓓ.
3. Select ►View recorded data, press ⓓ.
4. Select the file you want to view, press ⊙ SHOW. The files are identified according to the date and starting time of recording.

Checking the Recording Memory Status

You can check how much there is free space for recording in the memory.

1. Open MENU: press ⓓ.

2. Select ►Recording/Viewing, press ⓑ.
3. Select Memory status, press ⊙ SHOW to see the amount of memory in use and the estimated free space.
4. To return to the main view, press ⊙ OK and ⊙ EXIT.

Deleting All Record Files

The data memory can be cleared as follows:

1. Open MENU: press ⓑ.
2. Select ►Recording/Viewing, press ⓑ.
3. Select Clear data memory, press ⊙ CLEAR. Press ⊙ YES to confirm deletion of all recorded data files.
4. Press ⊙ EXIT to return to the main view.

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CHAPTER 14
OUTPUT INTERFACES

This chapter describes the serial communication settings and outputs of the DM500.

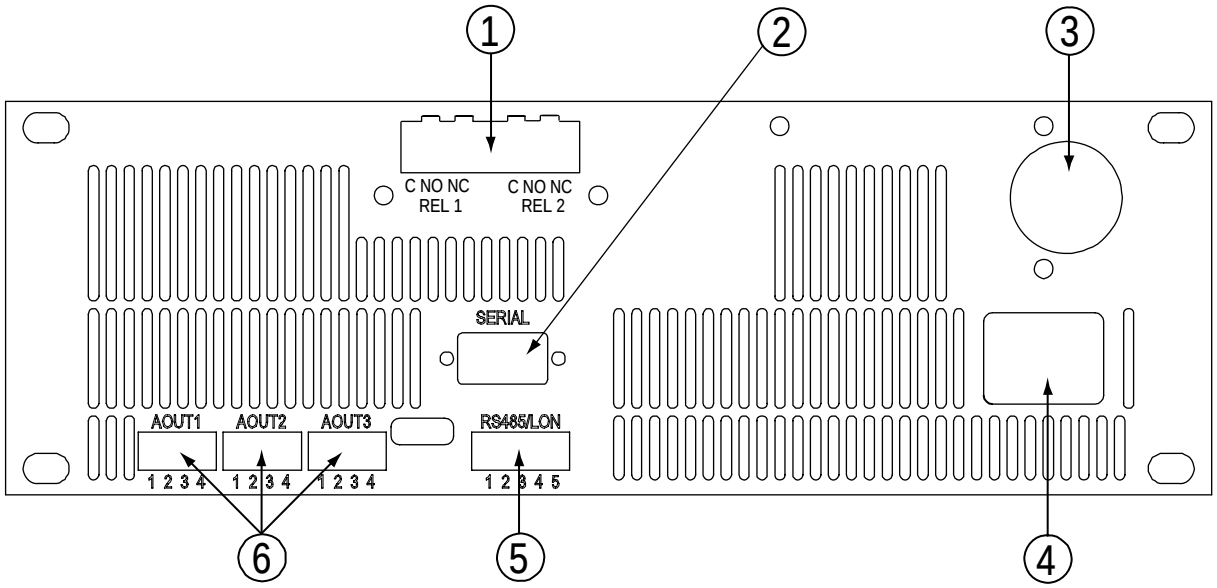

Figure 21 DMI500 User Interface Unit Back Panel (Same as Figure 3)

The following numbers refer to Figure 21 above:

1 = Relay outputs (optional)
2 = Serial port (EIA-232, RS232 for Terminal/MI70-link
3 = Connection to DMP501
4 = Mains cable
5 = RS485 and LonWorks-port (optional)
6 = Analog outputs (optional)

CAUTION	The dip switches behind the DMI500 **MUST NOT** be touched, because the processor may be destroyed as a result of false dip switch positions.

NOTE	Before connecting a PC to DMI500 or DMP501, make sure there is no ground potential difference between PC and the DM500.

Serial Communication Settings

Connect the DM500 to PC by using a serial cable (provided). When connecting EIA-232 (RS232), use the port called 'SERIAL'. When connecting optional RS485, use the port called 'RS485/LON'. Connect the RS485 as follows:

Table 2 4-Wire Connection

Terminal	Data Line
1	R+ (input to DM500) ←
2	R- (input to DM500) ←
3	T+ (output from DM500) →
4	T- (output from DM500) →
5	Shield

Table 3 2-Wire Connection

Terminal	Data Line
1	R/T+ connect the same line to terminals 1 and 3
2	R/T- connect the same line to terminals 2 and 4
3	R/T+ connect the same line to terminals 1 and 3
4	R/T- connect the same line to terminals 2 and 4
5	Shield

Select the DM500 communication mode and data transfer settings as follows:

1. Open MENU: press ⓓ.
2. Select ►Interfaces, press ⓓ.

3. Select ►Communications, press ⓓ.
4. Select Comm. mode, press ⊙ SET.
5. Select one of the following mode, press ⊙ SELECT:

   STOP: Outputs measurements only by command. All commands can be used.

   RUN: Outputs measurements automatically in a format set by a serial command FORM. Only serial command S can be used.

   POLL: Outputs measurements only with the serial command SEND.

   MI70 Link: Sets the MI70 Link program communication parameters. Other communication settings have no effect when using MI70 Link software.

6. Set the polling address if needed, select Polling address, press ⊙ SET.
7. Give the address for POLL communication mode by using numerical buttons, press ⊙ **OK**.
8. Select Baud rate, press ⊙ SET.
9. Select one of the following baud rate, press ⊙ SELECT:

   300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200 bps

10. Select Serial format, press ⊙ SET.
11. Select the data bits (7 or 8), parity (N = none, E = even, O = odd) and stop bits (1 or 2), press ⊙ SELECT.
12. Select Echo or Half duplex, press ⊙ NO/YES to turn the functions on/off.
13. To return to the main view, press ⊙ EXIT.

Analog Outputs (Optional)

DMI500 user interface can be equipped with three optional 4...20 mA passive current outputs. These 2-wire channels must be powered with 12...28 VDC external power supplies (not provided). The analog outputs are galvanically isolated from electronics but they are not isolated from each other. Thus, you need a separate (isolated) power supply for each monitored analog channel.

The port connections are as follows:

pin 1: ch+ (+VDC supply voltage)
pin 2: ch- (-VDC supply voltage)
pin 3: test (for service use only)
pin 4: shield

When using 12V loop voltage, the resistance must be less than 90 ohms. An approximate can be calculated by following formula:

$Rmax = (V_{loop} - 10V)/20mA$

You can scale the output to any output range. It is recommended to have the scaling within the measuring range to get accurate measurements.

1. Connect the analog output signal cable connector to the connector, see Figure 21 on page 73.
2. Open MENU: press ⓡ.
3. Select ▶ Interfaces, press ⓡ.
4. Select ▶ Analog outputs, press ⓡ.
5. Select ▶ Output 1, press ⓡ.
6. Select Quantity, press ⊙ SET , select the quantity for the analog output and press ⊙ SELECT.
7. Select Scale 4 mA, press ⊙ SET.
8. Press ⊙ CLEAR and give the lowest value (value represented by 4 mA current) by using numerical buttons. Press ⊙ OK.
9. Select Scale ...20 mA, press ⊙ SET.
10. Press ⊙ CLEAR and give the highest value (value represented by 20 mA current) by using numerical buttons. Press ⊙ OK.
11. Select ENABLED WHEN, press ⊙ SELECT. Now you can select the measurement status that activates the analog outputs.

    STOP: output is enabled when dewpoint measuring status is STOP.

    ERR: output is enabled when dewpoint measuring status is ERR.

    OK: output is enabled when dewpoint measuring status is OK

WAIT: output is enabled when dewpoint measuring status is WAIT

All the modes selected: output activity is not dependent on any measurement status.

None of the modes selected (never): output is not enabled (invalid output).

You can select any combination to control the output.

12. Select Invalid output to set the output reading when the output is not enabled. Press ⊙ SET (setting can be done also by using serial line, see command **AERR**).
13. Press ⊙ CLEAR and give the invalid value by using numerical buttons. The value of the invalid output shall be 4...20 mA. Press ⊙ OK.
14. Press ⊙ EXIT to return to the main view.
15. Set the other outputs similarly.

Analog outputs can be configured also by using the serial line (see command **ASEL**).

Relay Outputs (Optional)

The DMI500 user interface can be equipped with two configurable single pole double throw relays. The maximum voltage connected to relay terminals is 42 V DC/60 V Peak. Select the quantity, setpoints, and hysteresis and set the criteria for enabling the function.

1. Open MENU: press ⊙.
2. Select ► Interfaces, press ⊙.
3. Select ► Relay outputs, press ⊙.
4. Select ► Relay 1, press ⊙.
5. Select Quantity, press ⊙ SET , select the quantity for the relay output and press ⊙ SELECT.
6. Select Active above: xx, press ⊙ SET. Set the value above which you want the relay to be activated. Use the numeric buttons. Press ⊙ OK.

7. Select Active below: xx, press ⊙ SET. Set the value below which you want the relay to be released. Use the numeric buttons. Press ⊙ OK.

   When the measured value is in between the *above* and *below* values, the relay is passive. When choosing lower value as *above* value and higher value as *below* value the relay is passive when the measured values is not between the set values. You can set only one value or remove both setpoints by pressing DELETE. If both setpoints are removed the state of the relay changes on the basis of the measurement status, see further instructions.

8. Select HYSTERESIS, press ⊙ SET. Set the value by using numeric buttons. Press ⊙ OK.

   Relay is activated when the measured value passes the setpoint. As returning and passing the setpoint again relay is released only until the value is reached the setpoint decreased/increased by the hysteresis value.

   Hysteresis function is to prevent the relay switching back and forth when measured value is not stable near to the set point values given.

   Example: when the *active above* value is +20 ºC and the hysteresis value is 2 ºC, relay changes state when the dewpoint reaches 20 ºC. When the dewpoint decreases, relay changes state at 18 ºC.

9. Select ENABLED WHEN, press ⊙ SELECT. Now you can select the measurement status that enables function of the relays.

10. Set the measurement status that determines when the relays are enabled. Relay changes state on the basis of the measurement status if there are no setpoints determined. If the setpoints are determined the relay changes state on the basis of the setpoint when the selected measurement status is active. Otherwise the relay is disabled.

    STOP: relay is enabled when dewpoint measuring status is STOP

    ERR: relay is enabled when dewpoint measuring status is ERR

    OK: relay is enabled when dewpoint measuring status is OK.

    WAIT: relay is enabled when dewpoint measuring status is WAIT.

All the modes selected: relay function is not dependent on any measurement mode.

None of the modes selected (never): relay function is disabled.

You can select any combination of the measurement status.

Example: If you want to have relays working on the basis of the STOP and ERR mode to know when the measurement data is not valid, delete the setpoints and select enabled when: STOP and ERR mode.

11. Press ⊙ EXIT to return to the main view.
12. Set the other relay similarly.
13. You can test the relay operation with the Relay test button. Relay is forced to change state as long as you press the Relay test button.

Relays can be configured also by using the serial line (see command **RSEL**).

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CHAPTER 15

CALIBRATIOND AND ADJUSTMENT

This chapter provides you with information about the calibration and adjustment of the DM500.

General About Calibration and Adjustments

Calibration Interval

The DMP501 dewpoint sensing unit is fully calibrated as shipped from factory. The recommended calibration interval is one year. However, calibration shall be done if there is a reason to believe that device is not within the accuracy specifications.

In adjustment, the reading of DM500 is changed to correspond to the reference value. After adjustment, the original calibration certificate shipped with the product is not valid anymore.

Calibration Laboratory

The dewpoint calibration shall be carried out at Vaisala or in other calibration laboratory capable to perform high accuracy dewpoint calibrations traceable to national/international standards.

Calibrating DM500 Equipped with a Pump

If you have the DM500 with a pump, ensure that the sample flow rate from the humidity generator is sufficient. See the following example:

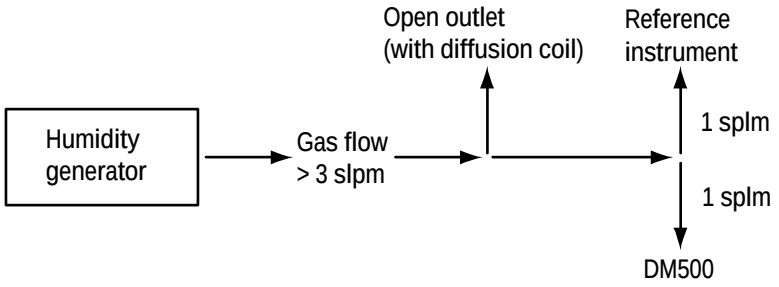

Figure 22 Gas Flow Rate from the Humidity Generator

Making an Adjustment

DMP501 needs 4...10 dewpoint reference points within dewpoint temperature range -80 ºC...+60 ºC for the adjustment. These dewpoint reference points shall be traceable to appropriate standards. The dewpoint temperature references shall cover the measurement area in which the instrument is used.

The adjustment can be done also by using the serial commands.

If you have adjusted the device earlier, you shall clear the previous adjustments before giving new adjustment data.

1. Open MENU: press ⓓ.
2. Select ▶Settings, press ⓓ.
3. Select ▶Adjustments, press ⓓ.
4. Select ▶Dewpoint adjustments, press ⓓ.
5. Press ⊙ CLEAR and ⊙ YES , OK to clear the old adjustment data

Connect the reference gas flow to the gas inlet and measure the readings in 4...10 points. Write down the readings in the different reference points. Feed the reference points and corresponding readings to the device to make the adjustment.

6. Turn the service switch 4 to ON-position (adjustment enabled), see page 18, Figure 4, DMP501 back panel, service switches.
7. Open MENU: press ▷.
8. Select ►Settings, press ▷.
9. Select ►Adjustments, press ▷.
10. Select ►Dewpoint adjustments, press ▷.
11. Press ⊙ SET. Give the reference value (Ref.) by using the numeric buttons. Then, give the measured value (Meas.). Press ⊙ OK.
12. Select with the arrow button the next reference point and press ⊙ SET.
13. Continue giving the references.
14. Make the adjustment by pressing ⊙ Adjust.
15. The adjustment result is shown.
16. Press ⊙ EXIT.
17. Turn the service switch 4 to OFF-position (adjustment disabled).

The system calculates a 3rd degree correction polynomial fitted to the adjustment data.

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CHAPTER 16

SERIAL LINE COMMANDS

The DM500 detector is operated via a serial line by using suitable terminal software like Windows Hyper Terminal (see also MI70-link). The serial output interface is RS232.Connect the RS232 cable to the connector on the back panel of the DMI500 user interface unit. The serial cable can also be connected to the back panel of the DMP501 sensing unit. This port, however, has a limited command set and fixed format (9600/8/1/none), and connecting to this port may increase the susceptibility to electromagnetic interference.

The notation '<cr>' used in this manual in conjunction with the serial commands stands for pressing the 'carriage return' (ENTER) key on your personal computer keyboard.

Serial Commands

Output commands

R*	Continuous output
S*	Stopping the continuous output
ADDR	Setting the device address
SEND*	Outputting one single reading
INTV*	Setting the output interval
FORM	Defining the output format

Operational commands

START*	Starting the measurement
STOP*	Stopping the measurement
PUMP*	Starting/Stopping the optional sample gas pump
HEAT*	Starting/Stopping the optional heater
SALT*	Enables/disables the salt contamination detection
SCAL*	Starts the salt detection limit determination cycle
PTEST*	Starts the cooling capacity test
ANAL*	Starting/Stopping the statistical filtering
FFROST*	Enables/disables the automatic forced freezing procedure

Setting commands

SERI	Setting the serial communication parameters
UNIT	Setting the units
TIME	Setting the date and time
RSEL	Setting the relays
ASEL	Setting and scaling the analog outputs
AERR	Setting the invalid output value for the analog channel
COOLER*	Setting the cooling method status
FLOW*	Setting the flow value
XFLOW*	Setting the flow value temporarily
PRES*	Setting the pressure
XPRES*	Setting the pressure value temporarily
TP*	Setting the temperature
XTP*	Setting the temperature value temporarily

Adjustment commands

CDP*	Adjusting the dewpoint temperature (in 4...10 points)
CTP*	Adjusting the temperature (in 2 points)
FCAL*	Adjusting the flow meter (in 1 point)
PCAL*	Adjusting the pressure sensor (in 2 points)

Others

?	Outputting the device settings
??	Outputting the device settings in POLL-state
DEL	Deleting the data files
DIR	Outputting list of data files
ECHO	Setting the echo ON/OFF
ERRS	Outputting the error messages
HELP	Outputting the commands
INIE*	Returning the factory settings
SMODE	Selecting the operation mode
OPEN	Opening the line in poll mode
CLOSE	Closing the line in poll mode
PLAY	Outputting the data file or history memory
SCC*	Sensor circuit check
SSC*	Sensor status check
SNUM*	Outputting the serial numbers of DM500
VERS*	Outputting the program name and version

*****when serial cable is connected to the DMP501 service port, only the commands marked with * can be used. Command syntax and output may be different in direct connection to DMP501 sensing unit.

Output Commands (DMI500)

R Continuous Output

Syntax: **R<cr>**

Outputting measured values continuously. You can modify the form of the output with the command **FORM** (see page 88). The resulting interval can be set with the command **INTV** (see page 87). The

command **R** does not change the default operation mode set with the command **SMODE**.

Example:

```
>r
 0.000 'C        0.00 'C            0.00 hPa    0.00
slpm
 0.000 'C        0.00 'C            0.00 hPa    0.00
slpm
```

S Stopping the Continuous Output

Syntax: **S<cr>**

Type **S** to stop outputting.

ADDR Setting the Device Address

Syntax: **ADDR xx<cr>**

where

xx = 0...99 (address)

The address is used in POLL mode when more than one device is connected to one serial line.

SEND Outputting One Single Reading

Syntax: **SEND x<cr>**

where

x = device address (0...99) in POLL state

INTV Setting the Output Interval

Syntax: **INTV xxx yyy<cr>**

where

xxx = output interval
yyy = unit (s, min, h)

Example:

```
>intv 1 min
Output interval:    1 MIN
>
```

FORM Defining the Output Format

Syntax: FORM [amount of decimals] [quantity] [u] [status] [date][time] [addr]<cr>

With the **FORM** command you can determine the output form of commands **R** and **SEND**. The following output fields can be defined after the command **FORM**:

The fields can be given in any order, except the unit field U, that can be given only after a quantity or after an error limit value. You can give only one field or several fields and write the field descriptions either in capital or small letters. Leave a space between the fields. The maximum amount of characters in the command is 80.

BASIC FIELDS

[amount of decimals] Type number of digits before and after the decimal point. As an example: giving **2.1** before the RH quantity outputs a reading with two digits before the point and one after the point, as follows: 80.1. You can define different amount of decimals before every quantity, if needed.

Type 0.0 to return the default setting

[quantity]	Type one or several of the following quantities: **TD/ TDF/ H2O/PW/RH/TW/A/ANTP/X/H/DT/T/P/FLOW/+TDF/ +TD/+PW** TD = dewpoint temperature TDF = dewpoint/frostpoint temperature H2O = humid air volume/dry air volume PW = water vapour partial pressure RH =relative humidity TW =wet-bulb temperature A = absolute humidity A = absolute humidity in NTP conditions X = mixing ratio H = enthalpy DT = difference of T and Td/f T = temperature P = pressure FLOW = sample gas flow rate +TDF = error limit value +TD= error limit value +PW = error limit value
[u] **[u1...u9]**	Type **U** to show a unit text after a quantity field. By typing **U1** results unit text with only one letter, **U9** results space-padded nine letters text. If needed, change the unit by using the separate command **UNIT** (or by using the display menu). This field shall be defined only after quantity field.
[status]	Type **STATUS** to insert the state of a dewpoint measurement system. The state can be one of the following: STOP (water content measurement not operating, OK (normal operation), WAIT, ERR (error in measurement).
[date]	Type **DATE** to have a date. The date is shown in form of: yyyy-mm-dd.
[time]	Type **TIME** to have a time shown. The time is shown in form of: hh:mm:ss.
[addr]	Type **ADDR** to have the device address (set with the **ADDR** command).

OUTPUT MODIFICATION FIELDS

[text field]	Type the text you want inside the quotation marks **"text"**.
[/]	Type / to return the factory setting of FORM command. Only alone, without any other specifiers.
[ASCII character]	Type **\xxx** where xxx is a three digit decimal number of the character, for example \035 outputs the # character.
[line feed]	Type **\n**
[carriage return]	Type **\r**
[space]	Type **" "** (Note! Leave a space in between the quotation marks)
[horizontal tabulation]	Type **\t**

If you have problems in typing \ (backslash) character, you can use # instead of it.

Use \\ for literal backslash and ## for literal hash.

Examples:

1. Output needed: Dewpoint/Frostpoint temperature with a unit label by using three digits before and after the point. The error value shown after the reading. Carriage return and line feed in the end.

```
>form "Tdf=" 3.3 tdf U +tdf U \r \n
"Tdf=" 3.3 Tdf U +Tdf U \r \n
>send
Tdf=  0.383'C  0.087'C
>
```

2. Output needed: Dewpoint/Frostpoint temperature and the error with a unit label. Time and status to be shown. The fields are separated with horizontal tabulation. Carriage return and line feed in the end.

```
>form "Tdf="3.3 tdf u \t +tdf u \t time \t status
\r \n
"Tdf=" 3.3 Tdf U \t +Tdf U \t TIME \t STATUS \r \n
>send
Tdf=  0.860'C     0.106'C       15:30:26        OK
>
```

3. Output needed: Relative humidity and pressure to be shown with a unit. The fields are separated with " " marks. Carriage return and line feed in the end.

```
>form 2.1 rh " " u " " 2.4 p " " u \r \n
2.1 RH " " U " " 2.4 P " " U \r \n
>send
23.0 %  1.0164 bar
```

Operational Commands

START Starting the Measurement

Syntax: **START<cr>**

Starts the dewpoint measurement and activates the cooling system.

STOP Stopping the Measurement

Syntax: **STOP<cr>**

Stops the dewpoint measurement and disables the cooling system.

PUMP Starting/Stopping the Optional Sample Gas Pump

Syntax: **PUMP ON/OFF<cr>**

Example:

```
>pump
Pump            : OFF
>
>pump on
Pump            : ON
>
>pump off
Pump            : OFF
>
```

HEAT Starting/Stopping the Optional Heater

Syntax: **HEAT ON/OFF<cr>**

Example:

```
>heat
Heat           :              OFF
>
>heat on
Heat           :               ON
>
>heat off
Heat           :              OFF
>
```

SALT Enables/Disables the Salt Contamination Detection

Syntax: **SALT ON/OFF [interval]<cr>**

Default: **SALT ON**

Example:

```
>salt
Salt sensing   :      OFF      24
>
```

Salt sensing is off.

```
>salt on
Salt sensing   :       ON      24
>
```

Salt sensing is on and detection interval is 24 h.

```
>salt 30
Salt sensing   :       ON      30 <cr><lf>
>
```

Salt sensing is on and detection interval is 30 h.

```
>salt on 24
Salt sensing   :       ON      24
>
```

Salt sensing is on and detection interval is 24 h.

SCAL Starts the Salt Detection Limit Determination Cycle

Syntax: **SCAL<cr>**

The determination of the salt detection limit can take several minutes. Please also see page 65 for more information about salt detecting.

Example:

```
>scal
Salt limit     :  0.36280
>
```

PTEST Starts the Cooling Capacity Test

Syntax: **PTEST<cr>**

During the test device reports the sensor temperature. When the test is completed, the lowest achievable stable sensor temperature (in current ambient conditions) is reported.

Example:

```
>ptest<cr>
-12.34 'C<cr>
-22.45 'C<cr>
-31.32 'C<cr>
-35.44 'C
...<cr>
-39.34 'C<cr>
Cool. capacity: -39.12 'C<cr>
>
```

Typing s<cr>
interrupts the test.

ANAL Starts/Stops the Statistical Filtering

Syntax: **ANAL ON/OFF<cr>**

Type command **ANAL ON** to turn off the statistical filtering. Command **ANAL OFF** turns on the statistical filtering. See section *Statistical Filtering* on page 61 for more information.

Example:

```
>anal on
Analog mode ???:                ON
>anal off
Analog mode ???:               OFF
>
```

FFROST Enabled/Disables the Automatic Forced Freezing Procedure

Syntax: **FFROST ON/OFF<cr>**

Default: **FFROST ON**

Example:

```
>ffrost
Forced freezing:                ON
```

Forced freezing is on.

```
>ffrost off
Forced freezing:               OFF
```

Forced freezing is off.

```
>ffrost on
Forced freezing:                ON
```

Forced freezing is on.

Setting Commands

SERI Setting the Serial Communication Parameters

Syntax: **SERI [baud] [parity] [bits] [stops] [duplex]<cr>**

where

[baud]	=	300/600/1200/2400/4800/9600/19200/38400/57600/115200
[parity]	=	N (none)/E (even)/O (odd)
[bits]	=	7 (7 bits)/ 8 (8 bits)
[stops]	=	1 (1 stop bit)/2 (2 stop bits)
[duplex]	=	H(half-duplex)/F (full-duplex)

The current settings are output if you give the command without the parameter fields. Factory default: 9600/8/none/1.

The fields can be given in any order. The new settings are valid immediately after the change. If you choose a half-duplex mode, the echo turns automatically into OFF-position.

```
>seri 19200 n 8 1 f
19200 N 8 1 FDX
>
```

UNIT Setting the Units

Syntax: **UNIT [x]<cr>**

where

x	=	unit **C** or **F** (dewpoint, temperature, wet-bulb temperature), **g/m3** or **gr/ft3** (absolute humidity), **g/kg** or **gr/lb** (mixing ratio), **kJ/kg** or **btu/lb** (enthalpy), **hPa** or **torr** or **psi** or **bar** (pressure), **slpm** or **scfh** (sample flow).
x	=	**m** (metric)or **n** (non-metric)

The unit is set by typing the desired unit(s) after the command **UNIT**. All the units change form metric to non-metric (or other way round) by typing **UNIT m** or **UNIT n**. The display units change simultaneously.

NOTE	When you want to have both metric and non-metric temperature units (C/F) for different quantities, select the units with keypad. The serial command **UNIT** changes all temperature units either to metric or non-metric.

Examples:

```
>unit ?
Output units   : 'C g/m3 gr/lb kJ/kg bar slpm
```

Selecting non-metric units

```
>unit n
Output units   : 'F gr/ft3 gr/lb Btu/lb psi scfh
```

Changing the pressure unit

```
>unit bar
Output units   : 'F gr/ft3 gr/lb Btu/lb bar scfh
```

TIME Setting the Date and Time

Syntax: **TIME [date time]<cr>**

where

date = yyyy-mm-dd (24 hour clock)
time = hh:mm:ss

Example:

```
>time
Current time:   2000-01-01 02:55:17
Enter new date (yyyy-mm-dd):    2001-10-05
Enter new time (hh:mm:ss):      12:07:00
```

RSEL Setting the Relays

Syntax: **RSEL [q1 q2]<cr>**

where

q1 = quantity for the relay 1
q2 = quantity for the relay 2

Select the quantity, setpoints and hysteresis and set the criteria for enabling the function. See more about the relays from page 77.

Use the following quantity abbreviations:

TDF/TD/H2O/RH/PW/TW/A/ANTP/X/H/DT/T/P/FLOW/+TDF/

+TD/+PW

Enabling criteria keywords:

OFF	relay is never enabled (inactive)
STOP	relay is enabled when dewpoint measuring status is STOP
ERR	relay is enabled when dewpoint measuring status is ERR
OK	relay is enabled when dewpoint measuring status is OK
WAIT	relay is enabled when dewpoint measuring status is WAIT
ON	relay is always enabled

Any combination of status STOP, ERR, OK and WAIT can be chosen. Keywords OFF and ON can be used only alone.

Example:

```
>rsel tdf t
Re1 Tdf  above :       20      'C ? 0
Re1 Tdf  below :      -20      'C ? -20
Re1 Tdf  hyst  :        2      'C ? 2
Re1      enable:              ERR ? wait ok
Re2 T    above :       30      'C ? 30
Re2 T    below :       20      'C ? -40
Re2 T    hyst  :        1      'C ? 3
Re2      enable:               ON ? wait ok
```

ASEL Setting the Analog Outputs

Syntax: **ASEL [x y z]<cr>**

where

x = quantity for the channel 1
y = quantity for the channel 2
z = quantity for the channel 3

Select the quantity and scaling and set the criteria for enabling the function. See more about the analog outputs from page 75.

Use the following quantity abbreviations:

TDF/TD/H2O/RH/PW/TW/A/ANTP/X/H/DT/T/P/FLOW/+TDF/

+TD/+PW

Enabling criteria keywords:

OFF	relay is never enabled (inactive)
STOP	relay is enabled when dewpoint measuring status is STOP
ERR	relay is enabled when dewpoint measuring status is ERR
OK	relay is enabled when dewpoint measuring status is OK
WAIT	relay is enabled when dewpoint measuring status is WAIT
ON	relay is always enabled

Any combination of status STOP, ERR, OK and WAIT can be chosen. Keywords OFF and ON can be used only alone.

Example:

```
>asel td rh t
Ch1 Td   lo    :      100      'C ? -80
Ch1 Td   hi    :       20      'C ? 20
Ch1      enable:        WAIT   OK ? wait ok
Ch2 RH   lo    :     -100       % ? 0
Ch2 RH   hi    :      100       % ? 100
Ch2      enable:               ON ? ok wait
Ch3 T    lo    :        0      'C ? -40
Ch3 T    hi    :       20      'C ? 60
Ch3      enable:               ON ? on
>asel ?
Ch1 Td   lo    :      -80      'C
Ch1 Td   hi    :       20      'C
Ch1      enable:        WAIT   OK
Ch2 RH   lo    :        0       %
Ch2 RH   hi    :      100       %
Ch2      enable:        WAIT   OK
Ch3 T    lo    :      -40      'C
Ch3 T    hi    :       60      'C
Ch3      enable:               ON
>
```

AERR Setting the Invalid Output for Analog Channel

Syntax: **AERR<cr>**

Analog output gives the invalid value when the output is not enabled or when analog readings are not available. The value of the invalid output shall be 4...20 mA.

Example:

```
>aerr
Ch1 error out  :        4      mA ? 20
Ch2 error out  :        4      mA ? 20
Ch3 error out  :        4      mA ? 20
>aerr ?
Ch1 error out  :       20      mA
Ch2 error out  :       20      mA
Ch3 error out  :       20      mA
>
```

COOLER Setting the Cooling Method Status

Syntax: **COOLER [WATER/AIR]<cr>**

Example:

```
>cooler
Cooler         : AIR
>
>cooler water
Cooler         : WATER
>
>cooler air
Cooler         : AIR
```

FLOW Setting the Flow Value

Syntax: **FLOW<cr>**

Sets the flow value in current unit selected with **UNIT** command. This command is used only when there is no flow sensor in the system. Flow value is needed for the dewpoint calculation algorithm, especially when the dew/frostpoint is changing.

Example:

```
>flow ?
Flow           :        1    slpm
>flow
Flow           :        1    slpm ? 1.5
```

NOTE	If the flow setting is frequently adjusted, e.g. by using an external flow meter as a flow input source, the command **XFLOW** is recommended.

XFLOW Setting the Flow Value Temporarily

Syntax: **XFLOW x.xxx<cr>**

where

x.xxx = sample air flow value

The function of **XFLOW** is the same as with the command **FLOW** except that with the command **XFLOW** the setting is valid only until power is turned off or the command **XFLOW** is given without parameters. After this the flow rate stored with the command **FLOW** is valid again.

PRES Setting the Pressure

Syntax: **PRES<cr>**

Sets the pressure if there is no pressure transducer in the system. The pressure value is needed in volume flow rate calculations in the T_d measuring algorithm as well as in $T_d \rightarrow$ ppm unit conversion.

Example:

```
>pres ?
Pressure       :   1.0132     bar
>pres 1.0
Pressure       :        1     bar
>
```

NOTE	If the pressure setting is frequently adjusted, e.g. by using an external barometer as a pressure input source, the command **XPRES** is recommended.

XPRES Setting the Pressure Temporarily

Syntax: **XPRES xx.xx<cr>**

where

xx.xx = sample air pressure value

The function of **XPRES** is the same as with the command **PRES** except that with the command **XPRES** the setting is valid only until power is turned off or the command **XPRES** is given without a pressure value. After this the pressure stored with the command **PRES** is valid again.

Example:

```
>pres 1.0231
Pressure:        1.0231 bar
>xpres 5.5
Pressure:           5.5 bar
>xpres
Pressure:        1.0231 bar
>
```

TP Setting the Temperature

Syntax: **TP<cr>**

Sets the temperature if there is no temperature sensor in the system. Set accurate process temperature values to achieve valid RH readings. Command has not effect if process temperature sensor is available.

Example:

```
>tp ?
Temperature    :       20      'C
>tp
Temperature    :       23      'C ? 23
>
```

NOTE If the temperature setting is frequently adjusted, e.g. by using an external thermometer as a temperature input source, the command **XTP** is recommended.

XTP Setting the Temperature Temporarily

Syntax: **XTP xx.xx<cr>**

where

xx.xx = temperature

The function of **XTP** is the same as with the command **TP** except that with the command **XTP** the setting is valid only until power is turned off or the command **XTP** is given without parameters. After this the pressure stored with the command **TP** is valid again.

Adjustments

In adjustment, the reading of DM500 is changed to correspond to the reference value. After adjustment, the original calibration certificate shipped with the product is not valid anymore. Adjustment commands are not affected by unit settings. Commands **CDP**, **CTP**, **PCAL**, **FCAL** always use ºC, bar and slpm units.

CDP Adjusting Dewpoint Temperature (in 4 ... 10 points)

Syntax: **CDP<cr>** or **CDP*<cr>**

1. Turn the switch 4 (page 12, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.
2. First, (before measuring the references), type **CDPZERO** to clear the calibration coefficients.

   CDPZERO<cr>

3. Take the measurements in reference conditions. Write down the data pairs of reference value and measured value.
4. Type **CDP**, then give data pairs consisting of reference value and measured value for a maximum of 10 calibration points. Input can be terminated by pressing ENTER. After data has been input, a confirmation is requested before previous calibration coefficients will be overwritten.

   <cr>CDP<cr>

After data has been input and confirmed, the calibration algorithm calculates the 3rd degree polynomial to describe the measured deviation as a function of the measured dew/frostpoint. The polynomial is calculated from the reference value by performing a least squares fit utilizing matrix inversion. This 3rd degree deviation model is then used for correcting the dew/frostpoint display.

The **CDP*** command displays also the coefficients of the correction polynomial, as well as the reference value and residual error for each calibration data point.

Example:

```
>cdp<cr>
  1. reference   : -39.99 <cr>
  1. measurement : -40.009 <cr>
  2. reference   : -30.01 <cr>
  2. measurement : -30.030 <cr>
  3. reference   : -20.01 <cr>
  3. measurement : -20.026 <cr>
  4. reference   : -9.98 <cr>
  4. measurement : -9.977 <cr>
  5. reference   : 0 <cr>
  5. measurement : -0.006 <cr>
  6. reference   : 10 <cr>
  6. measurement : 10.002 <cr>
  7. reference   : 19.99 <cr>
  7. measurement : 19.982 <cr>
  8. reference   : 29.98 <cr>
  8. measurement : 29.989 <cr>
  9. reference   : 39.98 <cr>
  9. measurement : 39.989 <cr>
 10. reference   : <cr>
<cr><lf>
Reference   Measurement<cr><lf>
    -39.990     -40.009<cr><lf>
    -30.010     -30.030<cr><lf>
    -20.010     -20.026<cr><lf>
     -9.980      -9.977<cr><lf>
      0.000      -0.006<cr><lf>
     10.000      10.002<cr><lf>
     19.990      19.982<cr><lf>
     29.980      29.989<cr><lf>
     39.980      39.989<cr><lf>
 Overwrite previous calibration ? Y/N<cr><lf>
OK<cr><lf>
>

>cdp *<cr>
  1. reference   : -39.99 <cr>
  1. measurement : -40.009 <cr>
  2. reference   : -30.01 <cr>
  2. measurement : -30.030 <cr>
  3. reference   : -20.01 <cr>
  3. measurement : -20.026 <cr>
  4. reference   : -9.98 <cr>
  4. measurement : -9.977 <cr>
  5. reference   : 0 <cr>
  5. measurement : -0.006 <cr>
  6. reference   : 10 <cr>
  6. measurement : 10.002 <cr>
  7. reference   : 19.99 <cr>
```

```
  7. measurement : 19.982 <cr>
  8. reference   : 29.98 <cr>
  8. measurement : 29.989 <cr>
  9. reference   : 39.98 <cr>
  9. measurement : 39.989 <cr>
 10. reference   : <cr>
<cr><lf>
Reference   Measurement<cr><lf>
    -39.990     -40.009<cr><lf>
    -30.010     -30.030<cr><lf>
    -20.010     -20.026<cr><lf>
     -9.980      -9.977<cr><lf>
      0.000      -0.006<cr><lf>
     10.000      10.002<cr><lf>
     19.990      19.982<cr><lf>
     29.980      29.989<cr><lf>
     39.980      39.989<cr><lf>
 Overwrite previous calibration ? Y/N<cr><lf>
   2.40135193E-01<cr><lf>
  -2.59960938E+00<cr><lf>
   9.08935547E+00<cr><lf>
  -1.30498052E+01<cr><lf>
-4.00089979E+01  -1.94864569E-02<cr><lf>
  -3.00300002E+01  -1.91654568E-02<cr><lf>
  -2.00259995E+01  -1.26176178E-02<cr><lf>
  -9.97700024E+00  -5.47681761E-03<cr><lf>
  -6.00000000E-03  -1.04680657E-03<cr><lf>
   1.00020003E+01  -2.92509794E-05<cr><lf>
   1.99820004E+01  -7.64131546E-04<cr><lf>
   2.99889994E+01   8.67143250E-04<cr><lf>
   3.99889994E+01   1.14340186E-02<cr><lf>
OK<cr><lf>
>
```

CTP Adjusting the Dewpoint Temperature (in two points)

Syntax: **CTP<cr>**

1. Turn the switch 4 (see Figure 4 on page 18, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.
2. Set the temperature sensor to the reference conditions. Wait until the reading is stabilized.
3. Type the command **CTP** and give the value of the first reference, press ENTER.

   CTP<cr>

   ```
   >ctp
   Tp :  20.0000  1. ref ? 21
   Press any key when ready ...
   ```

4. Set the temperature sensor to the second reference conditions. Wait until the reading is stabilized.
5. Press any key and give the value of the second reference, press ENTER.

```
Tp :  20.0000  2. ref ? 80
OK
>
```

FCAL Adjusting the Flow Meter (in one point)

Syntax: **FCAL<cr>**

1. Turn the switch 4 (see Figure 4 on page 18, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.
2. Set the flow meter to the reference conditions. Wait until the reading is stabilized.
3. Type the command **FCAL** and give the reference.

PCAL Adjusting the Pressure Sensor (in two points)

Syntax: **PCAL<cr>**

1. Turn the switch 4 (see Figure 4 on page 18, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.
2. Set the pressure sensor to the reference conditions. Wait until the reading is stabilized.
3. Type the command **PCAL** and give the value of the first reference, press ENTER.

   ```
   >pcal
   P1 ( bar )  ? 1
   Press any key when ready ...
   ```

4. Set the pressure sensor to the second reference conditions. Wait until the reading is stabilized.
5. Press any key and give the value of the second reference, press ENTER.

   ```
   P2 ( bar )  ? 3
   >
   ```

Others

? Outputting the Device Settings

Syntax: **?<cr>**

?? Outputting the Device Settings in POLL-State

Syntax: **??<cr>**

DEL Deleting the Data Files

Syntax: **DEL [file]<cr>**

where

file = 1...(number of the file to be deleted, file numbers are seen with the command **DIR**)

NOTE	Command **DEL** without the file number erases all data files!

DIR Outputting List of the Data Files

Syntax: **DIR<cr>**

ECHO Setting the Echo ON/OFF

Syntax: **ECHO ON/OFF<cr>**

ERRS Outputting the Error Messages

Syntax: **ERRS<cr>**

Outputs the error history of the device. By typing **ERRS RESET** you can empty the memory.

HELP Outputting the Commands

Syntax: **HELP<cr>**

Example:

```
>help
Available commands:
ADDR    CLOSE   COOLER  FLOW    ICE     INIE    INTV
OPEN PRES    PUMP    R       SALT    SEND    SMODE
SNUM    START STOP    TIME    TP      UNIT    VERS
ECHO    ALARM   ASEL
SERI    FORM    ERRS    ?       DIR     DEL     PLAY
HELP
```

INIE Reverting the Factory Settings

Syntax: **INIE<cr>**

Does not affect calibration, date, time or data file memory.

Example:

```
>inie
All user settings will be deleted!
Are you sure   :            (Y/N) ? Y
OK
```

SMODE Selecting the Operation Mode

Syntax: **SMODE x<cr>**

where

x = STOP, RUN, or POLL

The **SMODE** command is used to set or inspect the default operation mode of the EIA-232 (and optional RS485) interfaces.

STOP mode: After power-up the transmitter outputs its type and software version and then waits for further commands.

RUN mode: Continuous output starts automatically from power-up. Output can be defined with the command **FORM**. Only command **S** can be used.

POLL mode: Allows the communication with multiple transmitters or other digital instruments connected to one serial bus. Only the

commands **OPEN** addr and **SEND** addr can be used. The transmitter does not echo in **POLL** mode.

OPEN & CLOSE Opening and Closing the Lines

Syntax: **OPEN x<cr>**

where

x = 0...99 (address of the device)

Syntax: **CLOSE<cr>**

In STOP-mode: command **OPEN** has no effect, **CLOSE** sets the transmitter in POLL-mode.

In POLL-mode: command **OPEN** sets the transmitter temporarily in STOP-mode, command **CLOSE** returns the device to POLL-mode.

PLAY Outputting the Data File or History Memory

Syntax: **PLAY [file]<cr>**

where

file = 1...(number of the output file)

Example:

```
>play 9
File 9: 2001-10-18 15:38:56     (11)
Date       Time         RH       T       P       flow
yyyy-mm-dd hh:mm:ss     %        'C      bar     slpm
2001-10-18 15:38:56      45.876  +20.00  1.0132  1.00
OK
2001-10-18 15:39:01      45.876  +20.00  1.0132  1.00
OK
2001-10-18 15:39:06      45.742  +20.00  1.0132  1.00
OK
2001-10-18 15:39:11      45.742  +20.00  1.0132  1.00
OK
2001-10-18 15:39:16      45.666  +20.00  1.0132  1.00
OK
2001-10-18 15:39:21      45.666  +20.00  1.0132  1.00
OK
```

Use **PLAY** without the file number to output the contents of the history memory (i.e. contents of the graphical trend).

SCC Sensor Circuit Check

Syntax: **SCC ON/OFF xx<cr>**

where

xx = checking interval (h)

Example:

```
>scc
Sensor check   :       ON       6
>scc on 8
Sensor check   :       ON       8
```

SSC Sensor Status Check

Syntax: **SSC ON/OFF xx<cr>**

where

xx = checking interval (s)

Sets the transient recovery time (or disables transient recovery).

Turns the transient recovery ON/off.

Examples:

```
>SSC <cr>
Status check   :      OFF      24<cr><lf>
>

>SSC ON <cr>
Status check   :      ON       24<cr><lf>
>

>SSC ON 15<cr>
Status check   :      ON       15<cr><lf>
>
```

SNUM Outputting the Serial Numbers of DM500 and DMP501

Syntax: **SNUM<cr>**

VERS Outputting the Program Name and Version

Syntax: **VERS<cr>**

```
>vers
DMI500 / 1.25
DMP501 / 1.04
>
```

CHAPTER 17

MI70 LINK PROGRAM

This chapter provides instructions on using the DM500 together with the MI70 Link Program and a personal computer.

Installation

1. Connect the MI70 link cable between your PC and DM500's SERIAL port (on the back panel of the DMI500).
2. Go to the DM500 menu, select ►Interfaces, ►Communications, Com.mode: MI70 Link.
3. Insert the CD-ROM into your CD-ROM drive. The MI70 menu will be launched automatically in a few seconds. If the menu does not open automatically, double-click the "My computer" icon on your Windows® desktop, then the CD-ROM drive icon, and finally "Start" icon in the opened CD-ROM window.
4. In the MI70 program, download measuring results by selecting INDICATOR and DOWNLOAD FILES. To get more information about the program, press F1 to get HELP menu.

Device Name MI70⇔DM500

The on-line help of MI70 Link uses the name "MI70" for the device. When using the application with DM500, the MI70 means DM500.

Displayed Quantities

When downloading recorded data or using the real-time window, the quantities and units are determined by the current selections in the DM500's "Quantities and units" menu at downloading time.

Measurement uncertainty values are shown in own data table columns after quantities Td/f, Td and Pw (if some of these quantities are active).

Sensing Unit Status

The status information of the sensing unit is shown in numeric form in "Status" data table column. The numeric codes are:

-	measuring is stopped (STOP)
0	measuring is stabilizing (WAIT)
1	measuring has been stabilized (OK)
-1	error in sensing unit (ERR)

Real-Time Quantities

You can activate only three quantities with "Real-time settings" form. If you need to see four quantities in the device display and real-time window, select the quantities and units with DM500 console.

Real-Time Update Interval

DM500 saves real-time data with minimum interval of 15 seconds. If you choose a shorter real-time update interval in "Real-time settings", you will receive each value several times and the true time resolution will not be better.

Chart

You can draw up to three data series simultaneously onto graph. Measurement uncertainty data is drawn as an independent quantity.

CHAPTER 18

MAINTENANCE

This chapter provides information that is needed in basic maintenance of the product.

Cleaning the Sensor

Clean the sensor whenever the system gives a warning of contamination on the sensor. Cleaning is also strongly recommended before calibration and adjustment or when there is a reason to believe that the measurement is unstable or the offset has increased. Contamination typically causes a positive offset to the measured dewpoint when there is a liquid phase on the sensor. When measuring frostpoints, the instability of the measured value increases if the sensor is dirty, but usually there is no offset.

The sensor is robust and constructed of hard materials. Thus even frequent periodic cleaning of the sensor can be done without any concern of sensor wear down.

1. Remove the sensor cap.

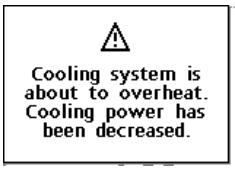
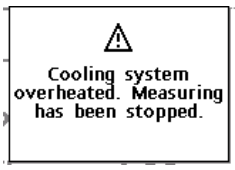
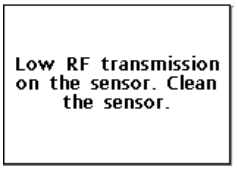
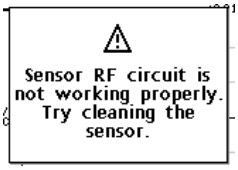
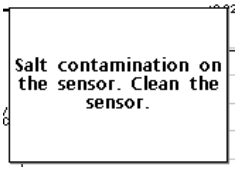
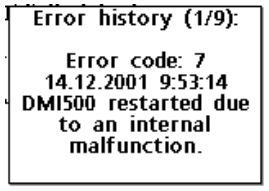
2. Clean the sensor surface

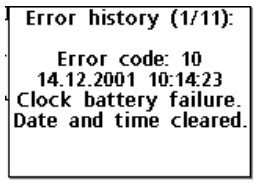
1. Turn off the measuring mode; the sensor must not be cooled.
2. Loosen the three Allen screws of the sensor cap with an Allen key. (Note that the screws have retainers, they do not come off completely).
3. Remove the sensor cap.
4. Take a rectangular piece of soft, clean paper tissue (optical or clean room grade tissue). Fold it twice to obtain a fourfold tissue and roll it diagonally into a tight roll. Wet one end of the roll with pure ethanol or isopropyl alcohol, firmly press the end of the paper roll against the vertical sensor surface (in the bottom of the hole) and clean the sensor with rotating movements. Make another paper roll and make a final cleaning with distilled water. Finally, dry the sensor with a dry paper roll.

   If using a cotton-wool stick, press the end of the stick against a clean surface to have a flat tip for cleaning.
5. After cleaning, the sensor surface should look like a clean mirror surface. There should not be any oily stains, spots, or dust.
6. If the system has warned of hygroscopic contamination on the sensor, it is recommended to clean the sensor 2-4 times with distilled water before the alcohol cleaning. The cleaning procedure with distilled water is the same as that with ethanol.
7. Replace the sensor cap and fasten the three Allen screws. See that the small o-ring at 2 o'clock is in place before replacing the cap.

If the sensor is very dirty, the sensing unit can be placed to upright position, and a small amount of cleaning liquid can be poured directly on the sensor element instead of wetting the tissue. Otherwise the cleaning is performed as described above, but the larger amount of water or solvent helps remove dirt without leaving residue. Be careful not to pour liquid into gas channel openings at 2 and 8 o'clock.

Error Messages

Error Message	Interpretation and Action
	Please check that the cooling air/water temperatures and flows are correct, see chapter *Setting up for Operation*, page 35. Check that cooling method (air/water) setting is correct, page 60. In case of constant error, please contact Vaisala, see page 19.
	Please check that the cooling air/water temperatures and flows are correct, see chapter *Setting up for Operation*, page 35. Check that cooling method (air/water) setting is correct, page 60. In case of constant error, please contact Vaisala, see page 19.
	Clean the sensor, see page 113. In case of constant error, please contact Vaisala, see page 19.
	Clean the sensor, see page 113. In case of constant error, please contact Vaisala, see page 19.
	Clean the sensor thoroughly using distilled water, see page 113 In case of constant error, please contact Vaisala, see page 19.
	DMI500 restarted due to an internal failure * Please contact Vaisala, send the device for repair, page 19.
	User settings damaged. Factory settings reverted* In case of constant error, please contact Vaisala, see page 19.

	Please contact Vaisala, send the device for repair, page 19.
	Clock battery failure. Please contact Vaisala, send the device for repair, page 19.
DMI500 selftest "C/D/F/L" failed. Let the service check the device.	Please contact Vaisala, send the device for repair, page 19.

Errors marked with are shown only in the error history log.

Technical Support

For technical questions, contact the Vaisala technical support:

E-mail	helpdesk@vaisala.com
Phone (int.)	+358 9 8949 2789
Fax	+358 9 8949 2790

Return Instructions

If the product needs repair, please follow the instructions below to speed up the process and avoid extra costs.

1. Read the warranty information.
2. Write a Problem Report with the name and contact information of a technically competent person who can provide further information on the problem.
3. On the Problem Report, please explain:
   - What failed (what worked / did not work)?
   - Where did it fail (location and environment)?
   - When did it fail (date, immediately / after a while / periodically / randomly)?
   - How many failed (only one defect / other same or similar defects / several failures in one unit)?

- What was connected to the product and to which connectors?
- Input power source type, voltage and list of other items (lighting, heaters, motors etc.) that were connected to the same power output.
- What was done when the failure was noticed?

4. Include a detailed return address with your preferred shipping method on the Problem Report.
5. Pack the faulty product using an ESD protection bag of good quality with proper cushioning material in a strong box of adequate size. Please include the Problem Report in the same box.
6. Send the box to:
   Vaisala Oyj
   Contact person / Division
   Vanha Nurmijärventie 21
   FIN-01670 Vantaa
   Finland

If only the sensor is faulty, return only the DMP501 sensing unit.

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CHAPTER 19

SPECIFICATIONS

This chapter provides the technical data of the product.

Measured Variables

Dewpoint Temperature

DM500S	(standard)	-40...+60 ºC T_d
DM500H	(high)	-60...+60 ºC T_d
DM500X	(extended)	-75...+60 ºC T_d

The upper limit value is with heating option only. Without a heating option, limited to ambient temperature. Standard calibration up to + 18 ºC T_d.

Accuracy	
standard (traceable to international standards)	±0.2 ºC T_d
optional (traceable to national primary standard)	±0.1 ºC T_d
Typical temperature dependence of measured dewpoint	0.01 ºC/ºC
Repeatability (see the following graph)	< ±0.05 ºC Td (2Σ)

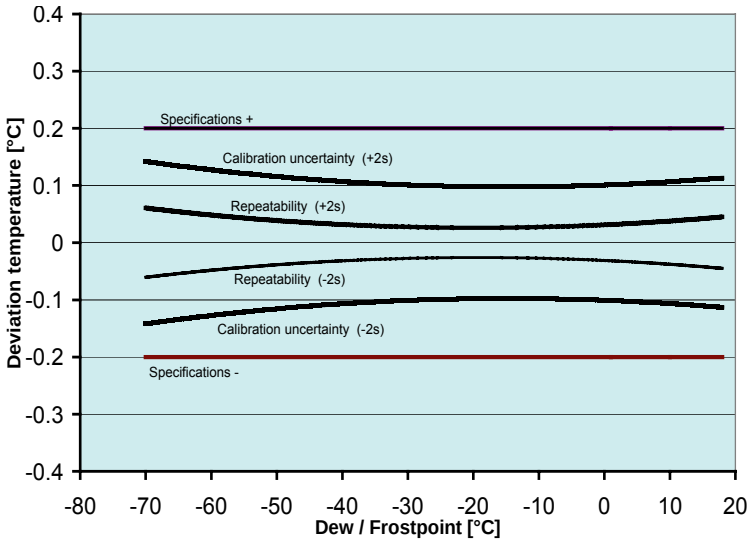


Figure 23 Dewpoint Temperature Measurement Repeatability

Response time (see the following graph)

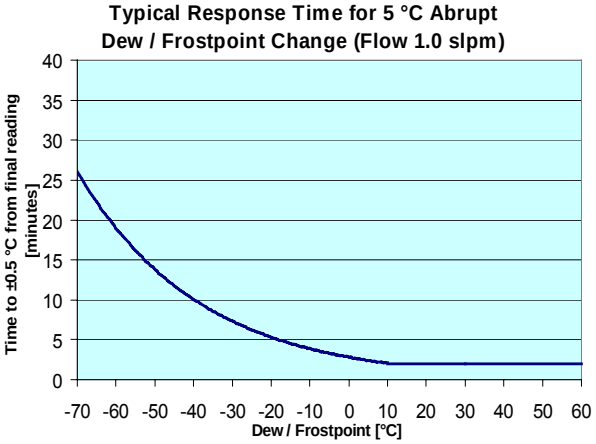


Figure 24 Dewpoint Temperature Measurement Response Time

External Temperature (Optional)

Sensor	Pt100RTD DIN IEC 751 class ¼B
Measurement range	-40...+80 ºC
Typical accuracy at +20 ºC	±0.1 ºC
Typical temperature dependence of electronics	0.001 ºC
Cable length	2 m/5 m/10 m

Integrated Pressure (Optional)

for ppmv calculations	
Measurement range	0...2 bar or 0... 20 bar
Accuracy	±1.0 % of full scale

Integrated Flow (Optional)

Measurement range	0...2 l/min
Accuracy	±10 % of reading
Integrated flow adjustment	

General

DMP501 Dewpoint Sensing Unit

Operating voltage (when used stand alone)	12 VDC, 25 A
Operating temperature	-10...+60 ºC
Pressure of sample gas	0...20 bar
Sample gas flow rate	1.0 slpm
Cooling water temperature	0...15 ºC
Operating gases	Air, N2, Ar, SF6; nontoxic, noncorrosive, nonflammable gases only.
Options may have extra restrictions.	
Electronics housing material	aluminium, stainless steel

Wetted parts' materials	Stainless steel (AISI 316L), silicone elastomer, Vectra LCP, tantalum, quartz
Housing classification	IP31 (NEMA 2)
Mechanical piping connections	Swagelok 6 mm/ /¼"
Storage temperature range	-40...+70 ºC
Weight	7 kg
Minimum heat removal capacity of the cooling water system	250 W @ 5 ºC

Options for DMP501

Pump	0...1 l/min, 0... 200 mbar differential pressure
Heated internal gas sampling	
Connection cable to DMI500	2.5 or 10 meters
Temperature probe	
Measurement range	-40…+80 ºC (-40…+176 ºF)
Typical accuracy	±0.1 ºC (±0.18 ºF)
Sensor	Pt100 PRT DIN IEC 751 class ¼ B
Cable length	2 m /5 m /10 m

DMI500 User Interface Unit

Operating voltage	100-230 VAC
Operating current	5A-3A
Operating power max	460 W
Display	B/W LCD with backlight
Menu languages	English, German, French, Finnish and Spanish
Operating temperature	0...+40 ºC
Storage temperature range	-40...+70 ºC
Electronics housing material	PPE + PS plastic, aluminium, stainless steel
Housing classification	IP31 (NEMA 2)
Weight	7.5 kg

Options for DMI500

Configurable alarm relays	60 VDC (42 V Peak)/0.75 A
Handle for portable model	
Front panel for rack installations	

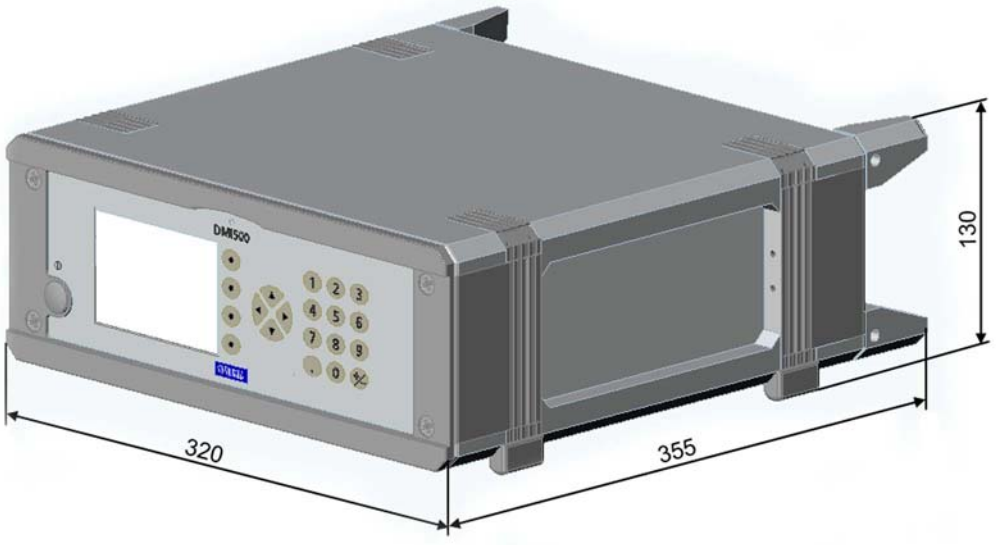
Outputs

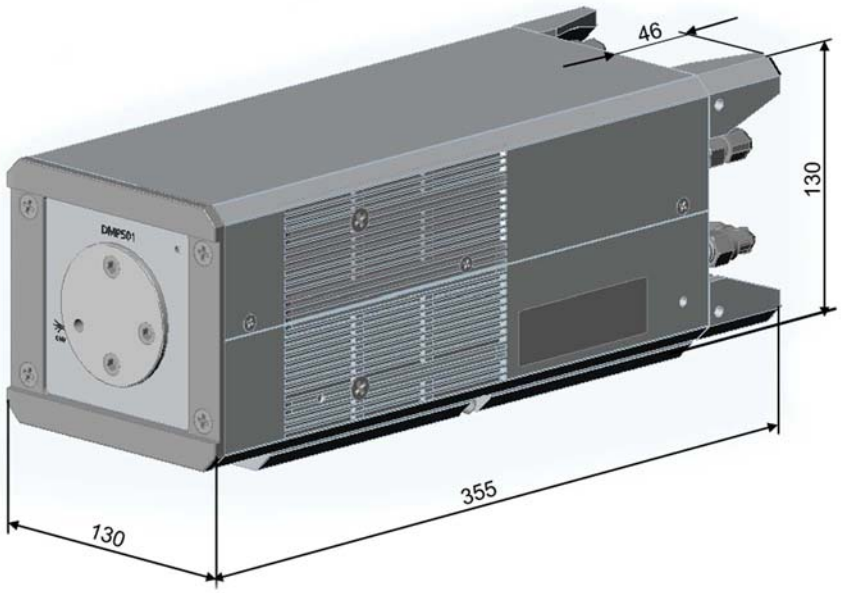
Digital	
EIA-232 (RS232) serial output	
RS485 serial output	
Analog outputs (optional, three channels)	4...20 mA passive
Operating voltage	12...28 V
ccuracy at +20 ºC (typical)	±0.05% full scale
Temperature dependence	0.005 % full scale/ºC

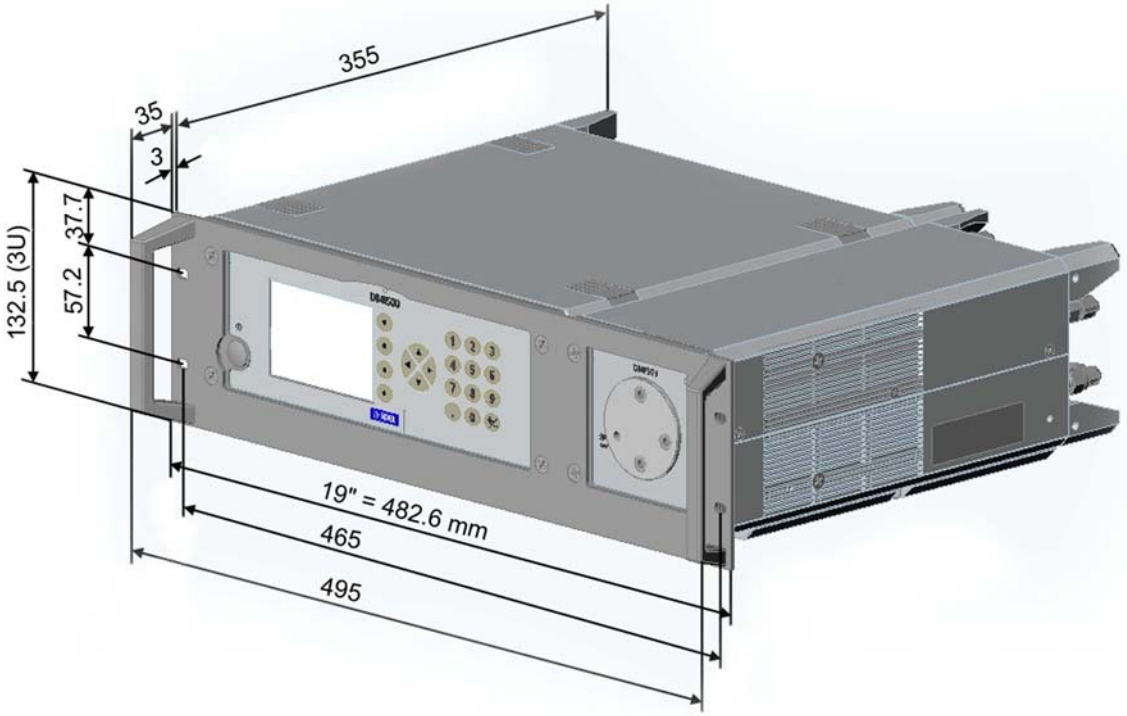
Electromagnetic Compatibility

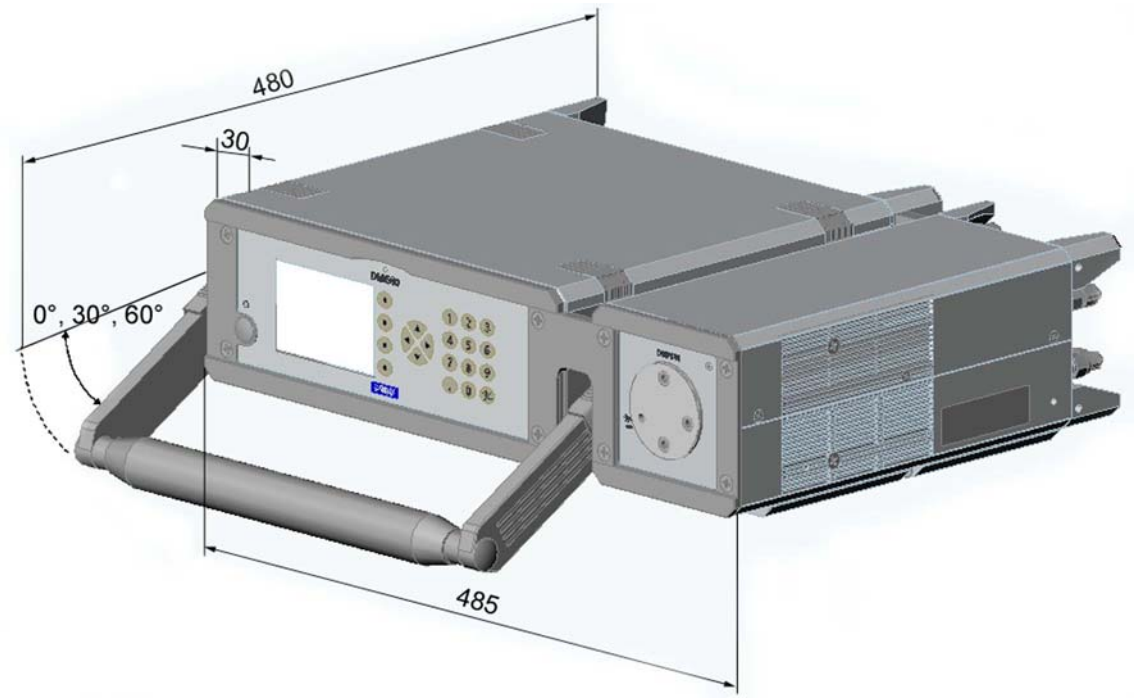
Complies with EMC standard EN 61326-1:1997 + Am1:1998;
Laboratory Environment

Dimensions (in mm)




46
130
355
130


355
35
3
132.5 (3U)
37.7
57.2
19" = 482.6 mm
465
495


480
30
0°, 30°, 60°
485

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APPENDIX A

HUMIDITY THEORY

This Appendix provides you with a basic explanation of the terms related to humidity theory that are used in many parts of this manual.

Measured and Calculated Results of DM500

DM500 measures the dewpoint temperature of a gas by condensing water on a surface and using SAW technology to detect this condensation. The temperature at which condensation occurs is accurately measured by a four wire platinum resistance temperature sensor and is reported as dewpoint/frostpoint temperature. Other humidity parameters are calculated by using the measured dewpoint/frostpoint temperature data and either measured or set values for pressure and temperature.

Water Vapor in Air

Water vapor is water in the gaseous phase. It is an abundant component of the earth's atmosphere, and it is also common in many industrial processes. At atmospheric pressure, water behaves like an ideal gas.

Dalton's law states that in a gas mixture, such as air, the total pressure of the gas is the sum of the partial pressures of each of the component gases

$$P_{total} = P_{nitrogen} + P_{oxygen} + P_{water} + P_{others} \quad (1)$$

Thus, atmospheric pressure is actually the sum of the partial pressures of nitrogen, oxygen, water vapor, carbon dioxide, and small amounts of other gases.

There are many ways of expressing the water vapor content of a gas. Some water vapor quantities, such as dewpoint temperature, can be measured directly and fundamentally. Other parameters, such as relative humidity, require knowledge of additional information, such as the temperature of the gas.

Saturation Vapor Pressure

Saturation vapor pressure is the maximum pressure of water vapor that can exist at a given temperature. This quantity is expressed in pressure units such as Pascals or millibars, and is often represented by the symbol "*e*." There is a unique saturation vapor pressure for any temperature. Thus, if a gas is cooled until condensation forms (the dewpoint temperature), it is possible to determine the saturation vapor by measuring the temperature at which condensation forms or remains in equilibrium.

Dewpoint Temperature (T_d)

Dewpoint is the temperature at which condensation begins to form when a gas is cooled. An object or surface is said to be at the dewpoint temperature when condensation is maintained in an equilibrium condition (amount of condensation is neither shrinking nor growing). Dewpoint has a unique correlation to the saturation vapor pressure of water. Accurate determination of dewpoint establishes knowledge of the partial pressure of water vapor in a gas. Knowledge of additional gas parameters, such as temperature and pressure, enable calculation of commonly used humidity parameters (percent relative humidity, parts per million by volume, mixing ratio, etc.).

Frost Point Temperature (T_f)

Dewpoints below 0 °C are often referred to as frost points, although the term "dewpoint" is often used interchangeably. Frost point is the temperature at which a gas is saturated with respect to a plane surface of ice. Saturation vapor pressure over ice is slightly lower than over water. This difference can be important in the temperature ranges below zero (0 ºC) where it is possible to have condensation either in the solid phase (frost) or in the liquid state (dew, supercooled water).

Partial Pressure of Water Vapor (P_w)

Partial pressure of water vapor refers to the part of the overall pressure exerted by the water vapor component of a gas. Note that the partial pressure of water vapor can be calculated when the dewpoint temperature of a gas is known.

$$Pw = A \cdot 10^{(m \cdot T_d / (T_d + T_n))} \quad (2)$$

Likewise, dewpoint temperature can be calculated for a given partial pressure of water vapor.

$$T_d = T_n / (m / \log_{10}(P_w / A) - 1) \quad (3)$$

where T_d is a dewpoint temperature T_n, m and A are constants and their value depend on the temperature range as follows:

over water	**A**	**m**	**Tn**
0...60 ºC	6.1078	7.5	237.3
-20...50 ºC	6.1162	7.5892	240.71
-70...0 °C (over ice)	6.1134	9.7911	273.47

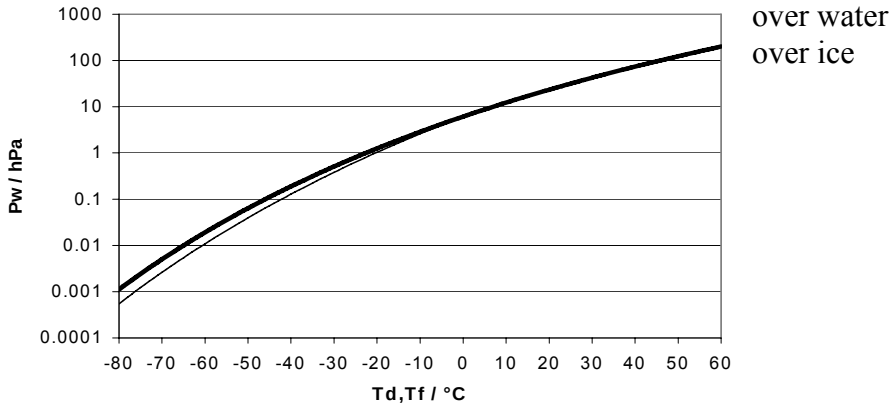

Figure 25 Partial Pressure of Water Vapor Over Water and Ice

Relative Humidity (RH)

Relative humidity (RH) is the ratio of the amount of water vapor actually in the air compared to the maximum amount the can be mixed

in air at that particular temperature. It is defined below as the ratio of the water vapor pressure P_w to the saturation water vapor pressure P_{ws}.

$$RH = P_w / P_{ws} \cdot 100\% \quad (4)$$

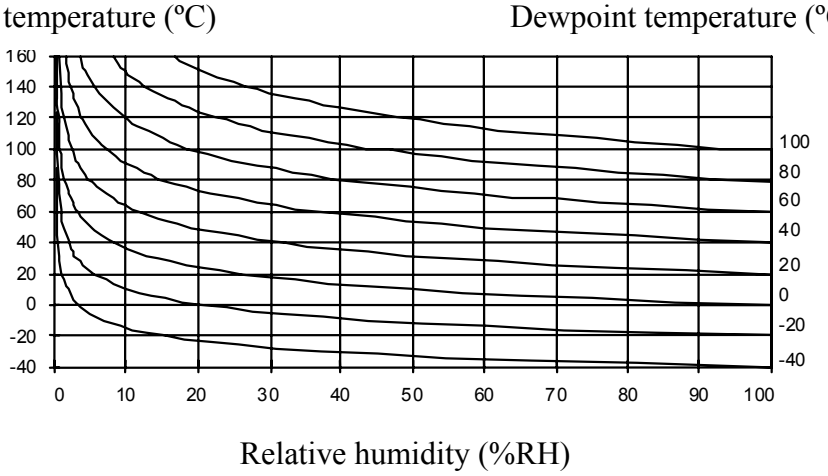

Figure 26 Water Vapor Saturation Curves

Mixing Ratio (x)

Mixing ratio (x) is mass of water vapour per unit mass of dry air with which it is associated.

$$x = 621.9907 \cdot \frac{P_w}{P_{tot} - P_w} \quad (5)$$

where

P_w = water vapor pressure (Pa)
P_{tot} = total process pressure (Pa)

Absolute Humidity (a)

Absolute humidity (a) is the mass of water vapour present in unit volume of moist air of a given temperature and pressure.

$$a = 2.16679 \cdot \frac{P_w}{T + 273.15} \quad (6)$$

where

T = temperature (ºC)
a = absolute humidity (g/m^3)
P_w = water vapor pressure

Absolute Humidity at NTP (aNTP)

$$a = 2.16679 \cdot \frac{P_{NTP}}{P} \cdot \frac{Pw}{T_{NTP}} \quad (7)$$

where

a_{NTP} = absolute humidity at NTP (g/m^3)
P_w = water vapor pressure (Pa)
P = pressure (Pa)

Normal conditions are defined as: $P_{NTP} = 101\ 325$ (Pa)
$T_{NTP} = 273.15$ (K)

Wet Bulb Temperature

$$P_w = P_{ws} - P_{tot} \cdot 0.000662 \cdot (T - T_w) \quad (8)$$

where

P_w = water vapor pressure (Pa)
P_{ws} = saturation water vapor pressure at temperature T_w (Pa)

Enthalpy (h)

Enthalpy (h) is measure of the total energy in a humid gas. Enthalpy is a function of the gas temperature and pressure, and of the moisture content, since water absorbs energy on changing from condensed state to vapour.

$$h = T \cdot (1.01 + 0.00189 \cdot x) + 2.5 \cdot x \quad (9)$$

where

x = mixing ratio (g/kg)
T = temperature (ºC)
h = enthalpy

Humid Air Volume/Dry Air Volume PPM_v

Parts per million (PPM) by volume is the ratio of the partial pressure of the water vapor to the partial pressure of dry gas. This can be calculated with a reasonable accuracy with following formula:

$$PPM_v = (P_w / (P_{tot} - P_w)) \cdot 10^6 \quad (10)$$

where

P_w = water vapor pressure
P_{tot} = total pressure

Effect of Pressure on Dewpoint

Changing the total pressure of a gas changes the partial pressures of the component gases according to Dalton's law, and therefore changes the dewpoint/frostpoint temperature of the gas. This can be represented as follows:

$$Pt_1 / Pw_1 = Pt_2 / Pw_2 \quad (11)$$

where

P_t = total pressure of the gas
P_w = partial pressure of water vapor

Using a Condensation Hygrometer

It is useful to consider the behavior of water vapor when working with any condensation hygrometer. Keep the following in mind when making measurements:

Contamination – Water soluble contaminants, such as salt, can have a significant effect on saturation vapor pressure. Some gases will also go into solution with water. Water soluble contaminants cause a lowering of vapor pressure known as Raoult Effect, and a corresponding measurement error.

Response Time – The response time of a hygrometer is proportional to the amount of water vapor in the gas being measured. Thus, at dewpoint temperatures of –60°C, things take ten times longer than at –40° because there is ten times less water vapor.

Condensation - It is important to remember that condensation will form on any surface if the temperature of that surface is at or below the dewpoint temperature of gas that is in contact with the surface. In practice, condensation may form in sample lines or on interior or exterior parts of the hygrometer. Condensation inside the sample line will cause a measurement error.

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